# REPORTS OF THE TWENTY-FIRST EXPEDITION OF THE LIVERPOOL SCHOOL OF TROPICAL MEDICINE

## JAMAICA, 1908-1909

### SECTION II

## MALARIA

BY

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## I. ACKNOWLEDGMENTS

I desire in commencing this Report to take the opportunity of expressing my gratitude to His Excellency the Governor, Sir Sidney Ollivier, for his great kindness, for the cordial reception which he gave us, and for the ready way in which he placed the whole official resources of the Island at the disposal of the Expedition. I have also to express my indebtedness to the late Colonial Secretary, the Hon. Clarence Bourne, whose untimely death, alas, occurred while we were in the island. Among other officials who rendered me great assistance, and to whom I desire to express my thanks, I may mention the Hon. Thomas Capper, Superintending Inspector of Schools, without whose assistance the splenic census would have been difficult; Lieut.-Col. Kershaw, the Inspector-General of Police and Prisons, for statistics in connection with the Police and Prisons; the Registrar-General, S. P. Smeeton, I.S.O., who furnished me with valuable statistics as to population, etc.; and the Director of Immigrants, Mr. F. L. Pearce.

I find it difficult to convey a sufficient appreciation of the debt which I owe to the capable and energetic head of the Medical Department, the Hon. Dr. Kerr, who placed every facility at my disposal, and without whose ready aid the work could not have been overtaken. I have also to thank the Medical Staff of the whole Island for their great hospitality and their assistance and help, often rendered, I am afraid, at the cost of very considerable inconvenience to themselves. Among so many helpers, it seems almost invidious to mention names, but I should like to place on record my indebtedness to Dr. Gifford, when Acting S.M.O., Dr. Neish of Spanish Town, Dr. Turton, Dr. Castle of the Public Hospital, Kingston; Dr. Moseley, Dr. Ritchie, Dr. C. H. C. Farquharson, Dr. Edwards, Dr. Hargreaves, Dr. Johnston, Dr. Harvey, Dr. Thompson, Dr. Myers, Dr. McCatty, Dr. Todd and Dr. Malabre.

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I am also indebted to the clergy, who rendered me great assistance, and to the schoolmasters, who gave me every facility

in the examining of children. All others, whom the exigencies of space forbid me to mention, I must ask to accept my most grateful thanks.

## II. INTRODUCTORY

In preparing this report, I have kept two objects in view; first of all, to give as scientific and accurate a description as possible of the prevalence and distribution of Malaria in Jamaica and of the measures necessary to diminish it, which I hope may be of some value and interest to other medical and scientific men who have to deal with similar problems elsewhere; and, secondly, at the same time, to do so in such a manner as will place the facts before the Executive and the general public of Jamaica in simple and non-technical language. For this purpose I have thought it advisable to enter into some details as to the history of malaria, the life history of the parasite, and the habits, etc., of the mosquito, which are now well known to, and accepted by, the scientific world, but which my visit to Jamaica showed me were not fully appreciated by the laity in the Island. Doubtless these details could be obtained from various reports and works, but experience shows that people will not take the trouble to wade through numerous blue books and papers in order to extract the necessary information from a mass of other details, and I hope that in this condensed form it will receive the careful study of those upon whom devolve the various health problems of the Island, and that a serious effort will be made to bring Jamaica abreast of modern progress in this direction. Jamaica has, unfortunately, allowed itself to fall somewhat behind; the sister islands in the West Indies are taking active measures in the direction of anti-malarial and anti-mosquito sanitation, and Jamaica must bestir itself if it is not to be outstripped.

And I should like to say that this condition of affairs is not due to want of appreciation of its necessity on the part of the Head of the Medical Department and the medical profession generally in the Island. One still occasionally meets a medical man who does not believe in the so-called mosquito 'theory' of malaria. If such exist in Jamaica I did not meet any of them. But I did find a body of men, most keen, energetic, enthusiastic, and fully up-to-date in modern scientific methods and in knowledge of the vast strides which

Tropical Medicine has made of late years, and quite prepared to apply these lessons if they received any encouragement. Rather, I think, it must be attributed to a certain amount of indifference on the part of the laity, and perhaps a fatalism due to lack of knowledge that such conditions are remediable; and I am sure that when once the facts are placed before the public, when they once appreciate the importance of dealing with this disease, which interferes so considerably with the prosperity of the island, and with the efficiency, the health and even the lives of its inhabitants, there will be no hesitation in dealing with it promptly and thoroughly.

## III. DESCRIPTION OF THE ISLAND

As there is such an intimate connection between the physical configuration of the Island and the conditions which affect the propagation of the mosquito and thus influence the prevalence of malaria, a brief description of the Island seems advisable.

It is situated between 17° 43′ and 18° 32′ North and 76° 11′ and 78° 20′ 50″ West. The extreme length of the Island is 144 miles and its greatest width 49 miles.

It is very mountainous, a great central chain trending generally east and west, dividing the island roughly into north and south portions. From this chain, a number of subordinate ridges or spurs run to the north and south, there again throwing off other ridges, so that the whole of the central part of the island resembles more than any thing else a huge table-cloth crumpled up into elevations and intervening depressions. Around the coast are flattened areas of varying size, and upon the extent of these and the number of rivers depends to a large degree the prevalence of malaria. (See Table I). The parish of Manchester, for example, with a total area of 302 square miles, has only 42 miles below 1,000 feet, the mountain ridges extending for the most part right down to the coastline. St. Ann, too, with 476 square miles, has only 85 below 1,000 feet. On the other hand, St. Thomas, one of the most malarious parishes in the Island, has 135 square miles out of 274 under 1,000 feet.

The mountains reach a considerable height, the highest being the Blue Mountain Peak, 7,360 feet high, while Sir John's Peak is 6,100, Portland Gap 5,569, Catherine's Peak 5,036, Morce's Gap 4,945, and many are over 3,000 feet.

Jamaica for the most part abounds in rivers and springs, though some parts of the western and midland districts are more or less destitute of water. St. Ann and Trelawny, for example, have no streams of any importance over the greater part of their area, and these parishes are among the least malarious. On the other hand, St. Thomas, Portland and St. Mary are well watered, having numerous large rivers which rush precipitously down from the mountains and spread out into broad shallow streams with swampy margins at their entrance into the sea. During the dry season many of these rivers form comparatively shallow, fordable streams, but owing to the shortness of their courses and the rapidity with which they descend from the hills, they are liable to sudden floods, and in a few minutes a peaceful stream is transformed into a dangerous raging torrent. This is well seen in the Yallah's district, where the river spreads out into a series of shallow mouths communicating with swampy grass-grown pools extending over a large area.

The mean rainfall for the whole Island from 1880 to 1906 was 76·9 inches, but the rainfall varies greatly in different parts, being greatest in the north-eastern division, where the annual rainfall is frequently over 100 inches. The driest months of the year appear to be January, February and March, while the greatest rainfall occurs in May, June and October. (See Tables II and III).*

The mean temperature varies according to elevation. In Kingston the mean temperature for eighteen years was 78·8, while in the mountains the temperature falls as low as 45°.

As the mountains are inhabited to a considerable height, it is thus possible to obtain a very large variety and range of climate, and in the upper parts it may be described as ideal.

Table IV* shows the average annual temperature at different elevations.

## IV. GENERAL HISTORY OF MALARIA

For the benefit of those who are unfamiliar with the history of Malaria, a brief sketch of the principal facts may be of advantage.

Malaria is a disease which has been recognised for many centuries and was known to the ancients as Marsh Fever, owing to its general

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* Meteorology of Jamaica, by Marshall Hall.

association with swampy ground, but until comparatively recent years nothing was known as to its causation. It has been attributed to many things—to the bad air or miasmata emanating from swamps (hence the name *Mal Aria*), to animalculae, inhaled from the air of swamps, to small vegetable cells, and to bacilli. But the relationship between these various supposed causes and malarial fevers was never proved, and it was not until 1880 that the discovery of the parasite of malarial fever was made. In that year Dr. Laveran, a young officer of the French army working in Algeria, discovered in human blood a minute protoplasmic body, which attacked the red cells, increased in size, developed black pigment, and underwent certain changes, which were found to bear a definite relationship to the stages of an attack of malarial fever.

Confirmation of these observations soon came from different parts of the world. In Italy, India, America, in fact, in every locality in which malaria existed, observers recognised and identified similar bodies, and it was quite clear that, at last, the definite cause of malaria had been determined. But though many additions to the life history of the parasite in the human body were made from time to time, and it was successfully transmitted from one individual to another, by means of injections of blood, for many years the method of its entrance into the human body was unknown. It was evident that it was not infectious, that is to say, it was not communicable directly from one individual to another by contact or proximity. It was thought that possibly the protozoal organisms lived in the water or soil of marshes, that they bred there, developed some form which was capable of aerial transmission and gained admission to the human body by inhalation. Others thought that drinking water was the medium of infection, but no proof was forthcoming of these theories, nor was it found possible to isolate any similar organisms in the soil, water or air of marshes.

In 1895, however, Professor Ronald Ross, then a medical officer of the Indian Army, now of the Liverpool School of Tropical Medicine, began an experimental study of a hypothesis which had been suggested, but which, up to that time, had been purely speculative, namely, that the mosquito was possibly the agent by which malaria was transmitted from individual to individual; and by a series of painstaking and brilliant researches, he succeeded in demonstrating

that the malarial parasite in man was taken up by a special variety of mosquito belonging to the sub-family Anophelinae, and that it underwent a series of definite developments in the body of the mosquito, culminating in the formation of small thread-like bodies, which collected in the salivary glands, and were finally injected along with the salivary juices into the human host, there to give rise to an attack of malarial fever similar to that in the original human host, and characterised by identical parasites.

These results were very soon confirmed by other observers in Italy and elsewhere, and some striking experimental demonstrations of the truth of this 'theory' were given. A number of Anopheline mosquitoes were fed on a patient in Rome infected with a mild variety of malarial fever, and were forwarded to London, where a volunteer, the son of Sir P. Manson, submitted himself to the bites of the infected mosquitoes, with the result that, although living in a locality where endemic malaria is now unknown, and without having lived in any other malarious locality, he developed a typical attack of malarial fever, and parasites, similar to those in the original patient, were identified in the peripheral blood. This experiment has been repeated more than once elsewhere.

Further, Doctors Low and Sambon, living in a mosquito-proof house, in the Roman Campagna, at the most malarious season of the year, remained free from malaria, while all around malaria was rampant among the natives; and that, without any other precaution than that of remaining within the mosquito-proof house from sunset to sunrise, the hours during which the Anopheline mosquito (whose habits are mainly nocturnal) came out in quest of food.

It was evident, then, that an enormous step in advance had been made. It had been found that the principal (and up to the present the only) method by which malaria is transmitted from individual to individual is by means of a particular species of mosquito; and the means of diminishing, and in some instances of actually eradicating, this terrible scourge, which for centuries has devastated the tropical parts of the globe and has rendered so many localities practically uninhabitable, was plainly indicated.

But the attention which had been drawn to the rôle played by mosquitoes in the transmission of malaria, had suggested the possibility of other tropical diseases being carried in the same way,

and it was eventually proved that Filaria, a blood worm said to cause Elephantiasis, whose life history in the mosquito had been fully worked out by Sir P. Manson twenty years before, obtained an entrance to the human body through the proboscis of the mosquito, while the brilliant work of American observers in Cuba showed that Yellow Fever was transmitted by means of another species of mosquito, namely, the Stegomyia.

The importance therefore of the mosquito as a disease-trans mitting agency, and the necessity for its reduction and, if possible, its complete extermination, has been clearly demonstrated.

## V. THE NATURE OF MALARIA

I have referred incidentally to the parasitic nature of Malaria, but for the benefit of the laity I may outline briefly the life history of the parasite, its mode of propagation and method of transmission, and I shall confine myself to facts which are universally recognised by the medical and scientific world and accepted by them as being definitely proved.

Malaria is caused by the admission into the blood, by means of a mosquito, and so far as we know by that means only, of a minute parasite. If we examine, microscopically, the blood of an individual suffering from an attack, we observe, in certain of the red blood cells, a minute speck of protoplasm, very often associated with small granules of black or dark brown pigment. These parasites gradually increase in size until eventually they involve the whole of the red blood cells. By this time, the parasite has undergone a process of division or segmentation, and consists of a body containing a number of rounded spores. Finally the body bursts and the spores are set free in the liquid of the blood, where they eventually attack a number of fresh red cells, and the process is repeated until the blood gets largely destroyed, and the patient dies or, under proper treatment, the parasites die out.

Three forms of parasites can be distinguished under the micro-scope, each differing in the duration of the life cycle. The first takes three days to form spores and causes Quartan Fever, the second takes two days to sporulate and produces Tertian Fever, while the third produces crops of parasites at irregular intervals and forms the Malignant types of Fever which are the most dangerous.

Now, as the malarial parasite is unable to leave the human body by the skin, the lungs, the bowels and the kidneys, it is impossible for it to be communicated directly from one individual to another, and it would eventually tend to die out, as has actually happened in many parts of the world.

But Nature, which invariably provides for the propagation of the species under suitable conditions, has here also made provision for the malarial parasite, and, as shown by Professor Ross, a special species of mosquito, the Anopheles, steps in as an intermediary.

If we again examine the blood, we find that certain of the malarial parasites do not follow the cycle which I have described and sporulate, but form crescentic or rounded bodies carrying brown pigment, which are easily distinguished under the microscope. These are the Sexual forms. When an Anopheline mosquito feeds on an individual having these particular forms in his blood, it draws a number of them into its stomach, where they undergo certain changes, and under favourable circumstances, in about a week, form threadlike bodies or spores which eventually find their way to the salivary glands of the mosquito situated at the base of the proboscis or trunk.

The mosquito has thus become 'infected,' and when it next bites an individual, at the moment when it inserts its proboscis, it injects some of the salivary fluid loaded with spores, which thus obtain admission to the blood, attack the red cells, and the cycle in the human body which I have already described begins once more, and the individual suffers from an attack of Malarial Fever. And thus the vicious circle goes on—man to mosquito, mosquito to man.

It is clear then that for the continuance and spread of Malaria two factors are required, and it is essential to recognise the fact that there are *two*, namely: (1) an individual whose blood contains the sexual forms of malaria, i.e., an *infected individual*; and (2) a species of mosquito, the Anopheline, which in its turn must also become infected, i.e. an *infected mosquito*. Do away with one or other or both of these factors and Malaria instantly disappears.

If we have no infected individuals, it does not matter how many Anophelines there are in a locality, they cannot become infected, and consequently cannot carry malaria; and conversely, if there are no Anophelines, it is immaterial how many infected individuals may be introduced into a locality, the disease cannot be transmitted and must inevitably die out.

And that being the case, it is equally clear, as I shall show directly, that in a locality where Malaria is prevalent, preventive measures against the disease must be directed against either of these factors, or, better still, against both.

## VI. THE ANOPHELINE MOSQUITO

I have mentioned that Malaria can only be transmitted by means of a particular species of mosquito, the Anophelines, and experiments carefully carried out in many parts of the world with the object of growing the malarial parasites in other varieties of mosquito have invariably been unsuccessful, so that we may take it as proved that the Anopheline is the *only* means by which Malaria is transmitted. This fact naturally is of very great assistance in our campaign against Malaria, for the Anopheline has special habits, special characteristics, and selects special conditions for breeding and growth, so that it is advisable that we should be familiar with these.

The life history of an Anopheles Mosquito, as of other insects, consists of four stages:—

1. First of all, the adult female lays its Eggs in water or near it, and in warm weather these hatch out in a day or two to form

2. The Larvae, short, wriggling bodies, which are familiar to everyone as occurring in standing water. They are provided with breathing apertures, and it is important to remember that they *must come to the surface to breathe.* The larvae of the Anopheline Mosquito may be recognised by the fact that, when in repose, they lie *flat* under the surface of the water, while the larvae of Culex and Stegomyia hang head downwards, with their tails and breathing tubes on the surface.

3. After about a week the Pupa is formed, a shorter body with a large head, which also has to come to the surface to breathe.

4. Finally, in two or three days the pupa develops into the adult Anopheline. The latter, when at rest, can generally be distinguished by their characteristic attitude. While the ordinary mosquito stands with its body parallel to the wall, the Anopheline rests with its body in the air, and its head and trunk as if boring down into the wall. It is important to note also that the habits of the Anophelines are mainly *nocturnal*—it comes out as a rule at dusk, and retires at sunrise. It is principally dangerous, therefore, for a limited number of hours.

The Anopheline Mosquito breeds in *shallow still* water or sluggish slowly-flowing streams, and especially where it is *weed* or *grass-grown* or contains green algae at the bottom. This is very important to remember. Thus the larvae will be found in shallow ditches, grass-grown edges of ponds, the shallow margins of streams, badly kept irrigation canals, and so on. It is rarely found in deep water clear of weeds. On the other hand, the Stegomyia or Yellow Fever mosquito breeds in old vessels, broken bottles, barrels, and, in fact, in anything which will hold water.

The **local conditions** in Jamaica under which I have found the larvae of the Anopheline mosquito may be classified as follows :—

1. Along the course and at the mouths of *Rivers*. As already mentioned, these spread out at their entrance into the sea so as to form swamps and shallow pools, all of which are more or less grass and weed-grown. This is well seen at Annotto Bay, where there are no less than three large swamps, formed by the two rivers which enter the sea at that place, and one of these, situated right in the centre of the town, of which a photograph will be found in the appendix, is a typical Anopheline breeding pool. Some of these swamps and pools are almost on the same level as the sea, and are formed by the sea banking up the sand, and thus preventing the outflow of the water. These conditions will be found the most difficult to deal with and improve. It is interesting to note that mangrove swamps do not breed Anophelines, and I once found a curious condition along a road—at one side a mangrove swamp free from Anophelines, and at the other side a grass-grown swamp with numerous larvae. Larvae will breed in slightly brackish water, but very rarely in water that is tidal or contains more than a certain proportion of salt.

In the valleys, along the courses of the rivers, where they spread out, and the stream becomes shallow and sluggish, similar conditions may be found, but wherever the course of the stream is rapid and deep, Anophelines are not to be discovered.

Occasionally, after floods, the depressions in the surrounding flat country become filled up with water and form suitable breeding places for mosquitoes. These are not important unless in the immediate vicinity of towns and villages.

2. The shallow grass-grown *Ditches* along the sides of the country roads, and the earthen gutters at the sides of streets in the towns are also breeding places. Where the surface drains in the towns are cemented, Anopheline larvae are not to be found.

3. Then, scattered about the country, there are a number of larger *Ponds* which are formed by surface drainage, and are chiefly used for watering cattle, and in certain localities, where water is scarce, as the water supply of a village. The margins of these are invariably grass-grown and full of Anopheline larvae. In Great Pedro Bay, where malaria is rife, these are the only sources of the Anophelines.

4. Larvae may also be found in the occasional *Pools* formed in depressions by rain, and I have even found them in the old *hoof-marks* of cattle when left undisturbed for some time.

5. Anopheline larvae are bred occasionally in *Wells*, especially if not very deep, and I have found them, but very rarely, in barrels and tanks used for the storage of water, but the latter are a fertile source of the yellow fever mosquito, the Stegomyia.

These may be taken to be the principal *natural haunts* of the Anopheline larvae, but there are other breeding grounds which are artificial and are the direct results of the methods of agriculture in the Island

6. In the banana plantations in the northern part of the Island, where, I am informed, the soil is very heavy, deep drainage is required for successful cultivation. Consequently trenching has to be extensively carried out, and along these *Trenches* a small trickle of water is generally to be found. Now, it was very interesting to me to observe that, wherever I found trenches clean and free from weeds, with a smooth bottom and an even gradient so that no pools could form, no Anopheline larvae were to be detected; but as certainly as I found a grass-grown trench with pools of water, so surely could larvae be discovered. And a well-known planter remarked to me that clean trenches meant good cultivation, so that what is good for the bananas is bad for the Anophelines.

7. In the southern and western parts of the Island, where the rainfall is much less, different conditions obtain. Here both in banana plantations and on some sugar estates, instead of drainage, irrigation

is required, and the smaller *Irrigation Canals*, when not kept clean, were found to be a fruitful source of Anophelines.

I may summarise, then, the principal breeding places in the Island:—

1. Swamps and pools in connection with rivers.
2. Shallow ditches and gutters.
3. Ponds caused by surface drainage.
4. Accidental and temporary pools.
5. Wells occasionally.
6. Drainage trenches.
7. Irrigation canals.

It was impossible for me in the limited time at my disposal to make anything like a complete survey of the various breeding places of Anophelines in different localities, but this has been done to some extent by Dr. Grabham, whose brilliant work on the mosquitoes in Jamaica is so well known, but it is very important that a general survey of the Island should be made, and the various breeding places mapped out. For this and other purposes every Tropical Government should possess an Entomologist.

I also found it impossible to attempt anything like a collection of mosquitoes; but the following remarks, kindly supplied for this paper by Mr. Newstead, Lecturer on Entomology to the School of Tropical Medicine, include a list of the principal species of Anophelines and other disease-bearing mosquitoes:—

'In January, 1905, the total known species of Jamaican mosquitoes 'was twenty-five. Theobald* gives descriptions of all these together 'with synoptic tables of the sub-families, genera, and species; and 'valuable data, contributed by Dr. Grabham, on the life-history and 'breeding places of these insects. Since the publication of this useful 'memoir seventeen additional species have been added to the list 'by Dr. Grabham, so that the total number of species now recorded 'for Jamaica is forty-two. Little attention was given to the Culicidae 'of the Island by the writer, as it was found altogether unnecessary to 'do so owing to the extensive investigations which Dr. Grabham has 'so ably conducted during the last ten years or so. This authority 'is now in possession of valuable data concerning the bionomics of

* The Mosquitoes of Jamaica. Inst., Jamaica, Date Tree Hall, 1906, pp. 1-40.

'the Jamaican mosquitoes, a great deal of which is new and note-
'worthy, and it is to be hoped that he will see his way, shortly, to
'publish the results of his investigations so that students and medical
'authorities may be in possession of facts, which would be
'indispensable in malarial and yellow fever prophylaxis. What is
'most needed at the present moment is a map showing the distribution
'and breeding places of the Anophelines and *Stegomyia calopus*
'(= *fasciata*), especially in those areas in which the towns and
'important villages are situated.

'The Anophelines are represented by four genera and five species,
'of which the following is a list, with the principal localities attached:
'*Anopheles punctipennis*, Say. Port Antonio is the only locality
'given for this mosquito.
'*Cycloleppteron grabhamii*, Theob. Lignanea Plain and Kingston.
'*Arribalzagia maculipes*, Theob. Port Antonio and Morant Bay.
'*Cellia albipes*, Theob. Kingston, the Ferry and Rockfort Swamps,
'Lignanea Plain, Bath, Bowden, Annotto Bay, Port
'Antonio, Bluefields, Castleton and Spaldings.
'This is apparently the most abundant Anopheline
'of the Island, and is said to act as the intermediary host
'of malignant malaria and also of *Filaria bancrofti*.*
'*Cellia argyrotarsis*, Desv. Kingston only; and, according to
'Theobald, is uncommon, but "acts as the transmitting
'agent of the blood worm *Filaria nocturna*."
'*Stegomyia calopus* (= *fasciata*). Theobald (loc. cit.) says that it is
'"a common insect in Jamaica." It was certainly the
'most prevalent species met with by the writer, and
'seems to be widely distributed in all suitable localities;
'the greatest number of larvae met with was at Stony
'Hill in the parish of St. Andrew.'

## Malaria and Muskeetos 130 Years Ago

Before leaving this part of the subject, I am sure that the people of Jamaica will be interested to learn that so far back as 1774 the association of mosquitoes with unhealthiness in Jamaica was recognised, though the actual causal relationship between the two was

* Theobald. Ibid. p. 17.

not appreciated. In looking over a very old history of Jamaica, in three volumes, published by T. Lowndes in 1774, a hundred and thirty-five years ago, written by one Edward Long, though his name does not appear on the title page, the following passages occur:—

'In the West Indies such low swampy places are still more fatal, 'and they are infected with muskeetos which seem as if placed there 'by the hand of Providence to assault with their sting and drive away 'every human being who may ignorantly venture to fix his abode 'among them. It is most dangerous to pass the night in such places, 'and it is at such times that these insects collect in swarms and make 'war on every daring intruder. . . . Such places in Jamaica are 'to be deemed unfit for habitation.'

And, later on, the author again remarks:—

'It has been observed that muskeetos are intolerably numerous in 'those places in the West Indies which are least adapted to human 'habitation. They are found in the greatest swarms among lagoons 'and swamps on the sea coast, and in little creeks sheltered with 'mangrove trees; in gullies which contain any stagnant water, in 'puddles in the flat country after the rainy seasons, and in river 'courses after the dry weather, where the water rests in detached 'hollows and becomes corrupted from the fermentation of aquatic 'weeds and subsided scum. Sometimes I have known them driven 'from their skulking holes by the violence of strong sea breezes to a 'considerable distance up the country; but in general among the 'mountains they are scarce, very diminutive and feeble. They are 'principally troublesome and in swarms after the periodical rains, 'when the lowlands are drenched with water and full of little 'puddles, where these insects deposit their eggs and multiply and 'breed. . . . . These insects cannot exist long nor propagate 'their species well without stagnant water. Dry weather, dry 'exposure, and a cool air are equally obnoxious to them; their 'favourite haunts, therefore, and such as seem most to promote their 'multiplication, are to be rejected as the least fit (in proportion) for 'mankind to inhabit, at least during those months of the year when 'they appear most vigorous and numerous.'

Our old-world author has mentioned nearly every place where Anophelines are now known to breed, and came very near anticipating the mosquito causation of malaria!

## VII. MALARIA IN JAMAICA

*Type of fever.* The clinical types of malaria which exist in Jamaica are the same as are found elsewhere, but so far as my short experience showed me, they are, on the whole, of a milder character than those with which I have come in contact on the West Coast of Africa and in Mauritius. But the severe types are by no means infrequent; there was one death from undoubted Blackwater Fever while I was on the Island, and I obtained the history of several others. Bilious Remittent attacks are also not uncommon.

I examined a number of blood films taken during acute attacks and identified both the parasites of the malignant tertian (aestivo-autumnal of the Italians) and of benign tertian. I was unable to make a systematic examination of a sufficient number of the films to come to any conclusion as to the proportion of the different parasites, but I have to thank Dr. Neish, the Medical Superintendent of the Leper Asylum, who has made special investigations into this subject, for his kindness in placing his figures at my disposal.

He states: 'I have examined over 2,000 blood films. Up to '1905, I have classified these;—the number was 1,636, resulting as 'follows:—

| | | |
|---|---|---|
| 570 | Benign Tertian | 72 Double Infections. |
| 384 | Aestivo-Autumnal | |
| 79 | Mixed | |
| 15 | Quartan | |
| 588 | Negative | |
| 1,636 | | |

'All the cases were fever and as far as could be ascertained had 'not had any quinine. A large proportion of the negative cases had 'well marked simple tertian symptoms, but there were no parasites in 'the peripheral blood.

'The benign tertian predominates after the October rains, the 'aestivo-autumnal during June, July and August.'

It is interesting to observe the considerable proportion of the malignant infections, in view of the fact which I have mentioned,

that the clinical types are undoubtedly milder, and it is an interesting speculation whether parasites having the same morphological characteristics do not exhibit in different countries different strains of virulence. It is also probable that climate and other surroundings affect the malignancy of the attacks, as is seen in cases coming to England from West Africa.

## Prevalence of Malaria

### *General and Malarial Death-rates.*

Before discussing the question of anti-malarial measures, it will be necessary to endeavour to arrive in some way at the degree of prevalence of malaria, and the extent to which it affects not only the death-rate, but the general health and efficiency of the population, and for the purpose I have prepared a Table (V) showing the total death-rate from all causes for each parish in the Island, the total death-rate from malaria, and the percentage of malarial deaths to deaths from all causes for the ten years ending 30th April, 1907; and I have here to acknowledge my indebtedness to the Registrar-General for his kindness in supplying me with the figures on which this table is based. I had hoped to construct a similar table with reference to the principal towns of the Island so as to arrive at the malarial death-rate of those places, which is very important, because the greater number of the important centres of population are situated on the coastline which is the most malarious, and it would most certainly have been found that the general malarial death rate of a parish is much influenced by the inclusion of those towns. But, unfortunately, the records do not appear to be kept in such a form as to render the figures for the principal towns readily available.

And the configuration of the parishes must also be borne in mind. Without exception each parish reaches to the sea, and has a considerable coastline, the inland part stretching well back into the interior of the Island, and being more or less mountainous. There are no parishes entirely inland. Had it been possible to draw a line round a considerable portion of the interior it would certainly have been found that large tracts of the higher parts of the Island are practically free from malaria, and that the high malarial death-rate

in certain parishes is due to a comparatively limited number of what may be termed plague spots, where malaria is rife; and this information would facilitate very much the application of the anti-malarial measures with which I shall deal presently. But I hope to arrive at this by another method.

Before considering the table, it is necessary for me to point out one or two sources of error. In the first place, no census has been taken since 1891, owing to financial reasons, and, as the Registrar-General rightly points out, the figures relating to population must be taken as approximate and subject to correction at the next census, which I trust will be taken in 1911. I ought also to mention that the slight discrepancy which may be observed between the Registrar-General's figures of the total death-rate and those given by myself are due to the fact that I have calculated the death-rate on the estimated population for the whole year, while he has taken the mean population calculated to the middle of the year.

There is another source of error which must be remembered so far as the malarial death-rate is concerned, and that is that a very large proportion of the deaths, more especially in the outlying parts of a parish are uncertified, and consequently a number of deaths which are registered as being due to 'fever' may be unconnected with malaria. Any illness associated with a rise of temperature, no matter what the cause, is invariably spoken of by the uneducated native as 'fever' and registered accordingly.

So that possibly a more accurate diagnosis might in some cases tend to reduce the malarial death-rate. On the other hand a number of complaints are complicated by malaria, which may be fatal, though the death is returned under the original head, so that this neutralises to some extent the other factor. And, further, the error is a constant one, it will probably occur to the same extent all over the Island and in different years, so that for practical purposes it will afford a very fair standard for comparison.

The table is one of extreme interest, and from it I have calculated the mean death-rates for the decennium 1898 to 1907, which for facility of reference I give below, but I would recommend the serious study of the large table to those who are interested in the health and sanitary condition of their respective parishes.

Average death-rates, etc., for decennium ending 30 April, 1907

| Parish | Average death-rate from Malaria | Average death-rate from *Other* causes | Average death-rate from *All* causes | Average percentage of Malarial deaths to Total deaths |
|---|---|---|---|---|
| St. Thomas ..... | 6·5 | 18·5 | 25·0 | 26·1 |
| St. Catherine ..... | 6·2 | 19·4 | 25·6 | 24·4 |
| Westmoreland ..... | 5·9 | 15·8 | 21·7 | 27·7 |
| St. Mary ..... | 5·9 | 18·0 | 23·9 | 24·6 |
| Clarendon ..... | 5·3 | 15·2 | 20·5 | 23·8 |
| Portland ..... | 5·3 | 19·3 | 24·6 | 21·9 |
| St. James ..... | 4·8 | 17·1 | 21·9 | 22·3 |
| Hanover ..... | 4·8 | 19·5 | 24·3 | 19·9 |
| St. Andrew..... | 4·0 | 23·9 | 27·9 | 14·6 |
| St. Ann ..... | 3·4 | 14·5 | 17·9 | 19·4 |
| Trelawny ..... | 3·4 | 20·8 | 24·2 | 14·4 |
| St. Elizabeth ..... | 2·9 | 15·6 | 18·5 | 15·8 |
| Kingston ..... | 2·4 | 26·3 | 28·7 | 8·6 |
| Manchester..... | 1·6 | 14·8 | 16·4 | 10·0 |
| Whole Island ..... | 4·4 | 18·1 | 22·5 | 19·7 |

It will be seen that for the whole Island the death-rate per 1,000 living, for the ten years in question was 22·5, by no means a high one, as compared with other tropical places. The death-rate attributed to malaria is 4·4 per 1,000, so that had there been no malaria the death-rate for the Island would have been only 18·1. The proportion of deaths attributed to malaria, to deaths from all causes, is 19·7 per cent., so that very nearly *one-fifth* of the deaths in the Island are caused by Malaria.

The mean death-rate from malaria, 4·4 per 1,000, is thus by no means a high one when compared with other malarious localities, for example Mauritius, where Professor Ross found that the average annual death-rate from malaria was 14·0 per 1,000. But the satisfaction which might be derived from this statement is very much modified by the fact to which I have already drawn attention, namely, that Jamaica is largely a mountainous island, that in the higher parts malaria is practically non-existent, and consequently if statistics were available we would find a very low death-rate from malaria over the whole of the centre of the island, and a high one in certain localities along the littoral.

That this is the case is brought out in the table. Manchester, which is an extremely mountainous parish and where the principal centres of population are for the most part situated at high levels, shows the lowest malarial death-rate of all, namely, 1·6 per 1,000.

On the other hand, St. Thomas heads the list with a malarial death-rate of 6·5 per 1,000. Here the local conditions are quite different. A number of large rivers, the Yallahs, the Negro, the Morant, and the Garden, rush sharply down from the Blue Mountains to spread out in the plain below into broad shallow streams with, in many cases, swampy outlets.

And the other parishes which show a considerable malarial death-rate, St. Catherine, Westmoreland, St. Mary, Clarendon and Portland, show much the same conditions, a mountainous hinterland with well-watered alluvial plains devoted largely to banana and sugar cultivation.

It is worthy of note that Kingston, which unfortunately possesses the highest death-rate in the Island, pointing to general insanitary conditions apart from malaria, shows a low malarial rate, the proportion of deaths from malaria being only 8 per cent., and a systematic malarial survey of the town would certainly show that malaria is limited to well defined areas. This immunity is undoubtedly due to the lower rainfall and to the fact that the surface drains are largely cemented, and it would be a comparatively easy matter to banish malaria entirely from the capital of the Island.

The deaths attributed to malaria in the whole island in 1907 were 4,094, while the total deaths from the same cause for the ten years was 34,695, an appreciable factor in the industrial and economic development of the Island.

But the actual death-rate from malaria does not represent fully the amount of that disease; the death-rate will depend upon the particular type of malaria prevalent, and also upon the degree of immunity which is undoubtedly acquired by a native population. They may suffer to a large extent from malaria though they do not die of it, and the extent to which malaria prevails not only affects the general health and physique of a community but interferes with its efficiency for industrial purposes and throws a very considerable financial strain on the colony of Jamaica.

It is necessary, therefore, to endeavour to obtain some idea as to its prevalence apart from actual death, and this can be done by a study of the hospital returns. Dr. Kerr, the Superintending Medical Officer, kindly obtained for me a series of returns from the various district hospitals showing the number of admissions from malaria from the year 1898 to 1907. These are, unfortunately, incomplete, one or two districts not having furnished full returns, but from the material at my disposal I have constructed Table VI, which shows the admissions to various hospitals for a number of years. Although the grand totals would be considerable, if all the hospitals were included, yet the table brings out one very important fact, that the admissions for malaria have increased very considerably during the past few years, chiefly since 1904-5. I also include a Table (VII) drawn up by Dr. Kerr showing the total admissions from malaria month by month in all the public hospitals of the Colony during 1907-8.

The increase of late years is brought out perhaps in a more graphic way in the following statistics which I have extracted from the Annual Reports of the Medical Department :—

| Year | Total admissions from all causes | Total Deaths | Death-rate per cent. | Malarial admissions | Malarial deaths | Malarial death-rate per cent. | Percentage of malarial to total admissions |
|---|---|---|---|---|---|---|---|
| 1904-05 | 16,103 | 669 | 3·7 | 4,827 | 89 | 1·8 | 29·9 |
| 1905-06 | 17,856 | 563 | 3·1 | 6,285 | 88 | 1·4 | 35·1 |
| 1906-07 | 21,555 | 661 | 3·06 | 7,113 | 99 | 1·3 | 32·9 |
| 1907-08 | 21,837 | 830 | 3·8 | 7,510 | 121 | 1·6 | 34·3 |
| Total | 77,351 | 2,723 | — | 25,735 | 397 | — | — |
| Average | 19,337 | 680 | 3·5 | 6,433 | 99 | 1·5 | 33·2 |

It will be seen that the total admissions to the various hospitals from all causes have risen from 16,103 in 1904-5 to 21,837, an increase of over 26 per cent., while the admissions due to malaria rose from 4,827 to 7,510, an increase of over 55 per cent. The total number of cases of malaria treated in the hospitals during the years 1904 to 1908

was 25,735, while the average admissions were 6,433 or 33·2 per cent. of the average total admissions. That is to say, that of all cases admitted to the hospitals of the Colony one-third are due to malaria, and, as Dr. Ritchie of Annotto Bay pointed out in connection with his returns, this does not represent the total amount of malaria, as a considerable proportion admitted for other causes are complicated with malaria.

It is true that the average death-rate from malaria in the hospitals, that is to say, the case mortality, is low (1·5 per cent.), but the importance of this large admission rate lies not only in the loss of labour, but in the great expense to the Colony. Taking the figures from the Annual Report for 1907-8, I find that the total cost of the hospitals (including Kingston) was £19,185 18s. 7d. But a third of the patients were admitted for malaria, so that a third of the cost may be charged against them. In other words, the cost of malaria in 1907-8 was approximately £6,395, and this amount is likely to increase.

From this point of view alone the necessity for energetic anti-malarial measures seems amply indicated.

The increase appears to be largely due, so far as I can judge, to a rise in the number of coolie admissions, and the hospitals which show the largest numbers of *malarial* admissions are those situated in the agricultural districts employing a large number of coolies and which also have the largest number of *coolie* admissions. In more than one Annual Report expressions like the following occur:—'Annotto Bay Hospital comes first with 1,780, while Port Antonio runs a good second with 1,611 cases, Lionel Town coming third with 933 cases.' Statistics as to the number of coolie admissions to hospital will be found in the Annual Report of the S.M.O. for 1907-8.

And as most of the coolies are indentured and are under strict regulations this is a factor which, as I shall show when dealing with the question of prevention, it should be possible to control to a very considerable extent.

### *Malaria on Estates.*

In order to obtain an idea as to the annual loss to estate owners from sickness among coolies, I requested Mr. Pearce, the Director of Immigrants, to be kind enough to supply me with a number of

statistics, and I have to express my indebtedness to him for the very considerable amount of trouble which he took in the matter. The labour involved made it out of the question to attempt to classify the whole of the estates in the Island, but a number of estates in different districts were selected by me entirely at random, without any personal knowledge of them, some being banana plantations and others sugar estates, and I presume they represent a fair average.

The return included females, but I have only taken into account the male indentured coolies.

Although a very accurate record is kept of the total number of days spent in hospital, no record is kept on the estates of the *nature* of the illness, although this might be obtained, with a great deal of labour, by extracting the information from the hospital records. I would venture to suggest that each estate should keep a record of the nature of the illness for which a coolie is sent to hospital, and this could be done by a simple return to be furnished to the estate by the District Medical Officer. It would be of extreme value in arriving at a knowledge of the prevalence of any disease on a particular estate, and for the purpose of indicating the remedial measures necessary.

But though the number of days lost through malaria are not specifically shown, I think I shall be under-estimating it if I put it at 50 per cent. of the total illness among coolies; in some places it is certainly much more.

I have in Table VIII condensed the information supplied by the Director of Immigrants, and it will be seen that the percentage of days lost through sickness varied from 2·4 to as much as 41·7, the average for 1907 being 15·5 and for 1908 18·3, the average for the two years being 16·9 days lost from illness out of every 100 working days. In other words, 16·9 men out of every 100 on these twelve estates were incapacitated from work daily throughout the year, that is to say, that if it were possible to attain the ideal of no sickness, these estates could have been worked with 16·9 less of a staff. On one or two estates, during certain months *each* individual coolie on the estate spent ten to fourteen days in hospital out of every month of twenty-eight or thirty working days. This, it must be admitted, represents an enormous loss of labour, in addition to what I have already alluded to—the cost to the Colony of maintenance in hospital—and I do not think it will be disputed by any practical business man that if it is

possible to reduce this amount of sickness appreciably, by measures directed against malaria, and at a reasonable cost, it is well worth while giving those measures a thoroughly systematic and determined trial. It will mean eventually that estates can be worked with a smaller staff as satisfactorily and efficiently as they are at present worked by a staff, a considerable proportion of which is permanently incapacitated by illness.

### *Malaria among the Constabulary.*

In the Jamaica Constabulary we have a body of picked men who have to attain a certain physical standard before enlistment, who are constitutionally sound at the time of admission to the force, and who live, on the whole, under favourable circumstances as regards food, clothing and housing. They ought, therefore to be a very good index of the prevalence of malaria in any given locality—if they suffer, much more will the general native population suffer.

Colonel Kershaw, the Inspector-General, has been kind enough to supply me with the number of cases of malaria at each station. To get an absolutely accurate idea of the prevalence of malaria in the force, one would have to obtain the number of days off duty from malaria and the proportion of average daily sick from malaria to average daily strength, and no doubt this can be readily obtained if required, but the present return (Table IX) is sufficiently accurate for comparative purposes, and I have only calculated the percentages at the principal stations where there are a considerable number of men, as with small numbers the figures of illness are more liable to error.

Here again we find Annotto Bay occupying the unenviable position of easily heading the list. Every man stationed at Annotto Bay has on average six to seven attacks of malarial fever every year. Port Maria, Buff Bay, Alley, May Pen, Port Antonio, Old Harbour, Savanna-la-Mar and Black River are all stations showing a high percentage of malarial attacks. Kingston shows a low malaria rate, while the higher stations in the Manchester districts are practically free.

The total number of attacks of malaria in the force in 1907 was 749, and in 1908, 820, a total for the two years of 1,569. If each attack incapacitates the man from duty for five days, which is

probably a low estimate, we obtain a total of 7,845 days lost in actual service during the two years.

*Spleen Rate.*

These various figures, the death-rate from malaria, and the Hospital admission rate, give of course only an approximate idea of the prevalence of malaria in a community, that is to say, of the number of infected persons in a locality. But it is obvious that a very large number of individuals will not be included in statistics derived from such sources. A great many people suffer from malaria and recover, and a large proportion of these receive no hospital treatment. It is evident, then, that the percentage of infected people must be very much larger than has been shown. The only absolutely accurate method of determining the exact proportion of infected individuals in the general population would be to examine the blood of a very large number of people, taken at random from the general population, for malarial parasites, and this would give us what has been termed by Christopher and Stephens the 'endemic index' of malaria. Such a process of microscopic examination is, however, a very laborious one, and occupies a very large amount of time, as parasites are frequently very difficult to detect, and consequently, this method is one which it is rarely possible to adopt.

But there is a method which gives a very fair indication of malaria in a locality, and which was first put in practice by Professor Ross in a comprehensive manner in connection with his recent visit to Mauritius. This depends upon the fact that malaria causes an enlargement of the spleen, and consequently the number of people with enlarged spleens—what Professor Ross calls the 'spleen rate'—is a fairly reliable index of the amount of malaria in a locality, for apart from Kala-azar, which so far as I know is non-existent in Jamaica, malaria is the only endemic disease which causes a chronic enlargement of the spleen.

And it has been proved that in a locality where malaria is endemic, children up to the age of fifteen or sixteen suffer to a large extent from enlarged spleen, while over that age it appears to diminish in size, and is less easily detected. In other words, the native, as he grows older, appears to acquire a certain degree of

immunity from malaria. For our purpose, therefore, it is only necessary to examine children under that age, and this method undoubtedly affords a very valuable index for comparative purposes of the prevalence of malaria in different localities.

Following the lines laid down by Professor Ross, I endeavoured to carry out a 'splenic census' as extensively as possible in different parts of the Island. Unfortunately, at the time of my visit, the schools, which afford the best means of examining a large number of children, were closed for a month owing to the Christmas holidays, and I found it very difficult to get together a considerable number. However, with the kind assistance of the District Medical Officers, and of the Clergy, I was able to examine personally 2,036 children, and the interesting results are shown in Table X. In addition to obtaining the total number with enlarged spleens, I was at some trouble to obtain exactly the degree of enlargement and have, as suggested by Professor Ross, divided the spleens into four groups: normal spleens, and those showing three, six and nine inches degree of enlargement respectively. This gives what Ross calls the *Average Spleen*, and, as he points out, is more likely to give a more delicate index of the amount of malaria in a given locality than the simple spleen rate.

I am unable to obtain from the Registrar-General's returns any idea of the total number of children in the Island up to the age of 16, but in any case, with such a small proportion as 2,036 it is manifest that it is impossible to draw any sweeping generalisation, nor is it possible to make any comparison with the parochial death-rate, because the latter is calculated for the whole parish, while my observations were confined to small areas. But the Table is of very considerable value in this respect, that it enables us to place our finger with absolute certainty on certain spots where the endemic index is very high, and it enables us with equal certainty to exclude certain localities from the malarial area, and is of importance as indicating the localities to which anti-malarial measures should be applied without delay, and as excluding others where the urgency is not so extreme.

The following table gives the results in the different parishes. Of the children examined, over a fourth showed enlargement of the spleen.

Table showing spleen rate in various parishes

| Parish | No. of children examined | Spleens | | | | Total No. of enlarged spleens | Spleen rate | Average spleen |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 3 | 6 | 9 | | | |
| Portland ..... | 291 | 112 | 152 | 26 | 1 | 179 | 61·5 | 2·5 |
| St. Mary ..... | 398 | 216 | 158 | 22 | 2 | 182 | 45·7 | 2·1 |
| St. Thomas ..... | 44 | 27 | 10 | 6 | 1 | 17 | 38·5 | 2·3 |
| St. Catherine ..... | 212 | 156 | 48 | 7 | 1 | 56 | 26·4 | 1·6 |
| St. Elizabeth ..... | 249 | 195 | 47 | 7 | 0 | 54 | 21·2 | 1·5 |
| Kingston ..... | 220 | 197 | 23 | 0 | 0 | 23 | 10·4 | 1·2 |
| Westmoreland ..... | 278 | 255 | 17 | 5 | 1 | 23 | 8·2 | 1·2 |
| Trelawny ..... | 189 | 187 | 2 | 0 | 0 | 2 | 1·06 | 1·03 |
| St. Ann ..... | 69 | 69 | 0 | 0 | 0 | 0 | 0 | 1·0 |
| Manchester..... | 42 | 42 | 0 | 0 | 0 | 0 | 0 | 1·0 |
| Chapelton ..... | 44 | 44 | 0 | 0 | 0 | 0 | 0 | 1·0 |
| Total ..... | 2,036 | 1,500 | 457 | 73 | 6 | 536 | 26·3 | 1·2 |

In the St. Thomas Parish, time did not permit of my paying more than a flying visit, for which I was indebted to Dr. Edwards. At Albion, where I was only able to collect ten children, chiefly coolies, the percentage of enlarged spleens was 80, while at Yallas it was only 28·4 per cent. I have no doubt whatever that at Morant Bay and other coast villages the spleen rate would be found to be very high.

In the Portland Parish I was able, through the courtesy of Mr. Plant, the head master, to examine a considerable number of children at the Titchfield School, and though no doubt many of these came from the poorer classes, I was very much impressed with the intelligence, the good physical condition and, on the whole, the cleanliness and the evident care bestowed on the children by the parents; but even under these conditions the spleen rate was found to be from 53 to 56 per cent., diminishing as the children got older. It was interesting to note that the children residing on the ridge on which the Hospital and principal houses are built showed an almost entire absence of enlarged spleens, indicating a comparative freedom from malaria. In the lower parts of the town, however, for example, the East end and the Bound Brook side, both low-lying, badly drained and swampy, the percentage rose as high as 81·8. Here, whole families were found to be anaemic, cachectic and saturated with malaria. It ought to be noted that in this locality the examinations

were almost entirely among negro children, showing their very marked susceptibility at an early age, and it was also found that the tendency to enlargement of the spleen was greater among coloured children than among those of purer negro blood.

On the banana estates, where unfortunately the number of children examined was smaller, the percentage was very high, in two instances reaching 100. This was among the coolie population.

In this parish the average size of the spleen was two and a half times the normal.

In the parish of St. Mary, where, with the assistance of the District Medical Officers, Drs. Ritchie and Farquharson, I was able to cover a very considerable area, the spleen rates were also found to be high, an average of 45·7 per cent. Annotto Bay showed a spleen rate of 69·8 per cent., falling to 26 per cent. at Enfield, which is some two or three hundred feet above sea level.

The influence of altitude in diminishing malaria was shown at Brown's Town, where no enlarged spleen was detected. The same was found to be the case at Mandeville, and at Betheltown, both at very considerable elevations. Chapelton also showed no enlarged spleens, though there were some cases of malaria in the hospital.

This method of examination brings out the marked differences there may be in localities which are contiguous. For example, at Great Pedro Bay the percentage of enlarged spleens was 54 per cent., whereas at Newell, a short distance off, but 220 feet above sea level, it was only 2·9 per cent. This was clearly due to the character of the soil affecting the breeding places of mosquitoes. At Great Pedro Bay there were numerous grass-grown ponds in which Anopheline larvae could be found, whereas at Newell the country was almost entirely waterless, the soil being sandy and well drained, and the water supply derived from a few deep wells.

St. Catherine showed similar variations. Salt Pond, swampy, and situated in the midst of the banana plantations, artificially irrigated, showed a percentage of 69·2, while Spanish Town, long with a very unenviable reputation, but now with improved surface drains, showed only 17·3 per cent.

In the Black River District, one sugar estate where artificial irrigation was employed, and where a number of coolies lived in the

'rice pieces,' gave 75 per cent., while another under different conditions showed no enlarged spleens.

In Kingston, among the 220 children whom I was able to examine, there was only a percentage of 10·4. A complete splenic census of the towns would, however, show considerable variations.

It is evident, then, that in this method we have one of considerable value in determining the distribution and prevalence of malaria; and I would suggest the advisability of undertaking a more comprehensive splenic census, by having all the schools of the Colony systematically examined. The examination is a very simple one, and will require only a few seconds for each child. Two points only need be noted: the presence of enlarged spleen and the size. The age, sex, and race of child can be supplied by the teacher. The importance of this information will be evident when I discuss one of the methods of prophylaxis.

I should like to mention a point here which struck me very much in examining the schools, and that is, that the school registers in most cases showed the most marked variations in attendance, the number of absentees rising enormously at certain periods. This must inevitably interfere very much with educational progress, and tend to lower the standard, and as a considerable proportion of these absences are undoubtedly due to malaria, any diminution in that disease among the children which would promote more regular attendance would indirectly foster the cause of education.

## SUMMARY

I may now summarise the facts which we have ascertained regarding the prevalence of malaria:—

1. The total malarial deaths for the whole Island during ten years amounts to 34,695.

2. This is equivalent to an average annual death-rate of 4·4 per thousand.

3. The average percentage of malarial deaths to total deaths is 19·7, representing nearly one-fifth of the total deaths.

4. The total admissions to hospitals from *all causes* has risen from 16,103 to 21,837 in four years, an increase of 26 per cent.

5. The total admissions from malaria have risen from 4,827 to 7,510, an increase of 55 per cent.

6. Over 33 per cent. of the total admissions were due to malaria.

7. The annual cost to the Colony of treating malarial patients in hospital is over £6,300.

8. The annual loss of labour from malaria among indentured coolies on certain estates amounted to 16·9 out of every 100 working days.

9. Among the Constabulary, the loss of working days from malaria in two years amounted to 7,845.

10. The Average Spleen Rate among the children examined was 26·3 per cent., or over a fourth with enlarged spleens.

11. The Average Spleen was 1·2.

12. There is a large interference with education on account of illness, which is preventible.

Of course it must be admitted that the conditions at Ismailia were extremely favourable, the area of land to be dealt with was limited, and the conditions very easy, but the results demonstrate very clearly the *immediate* effects of systematic anti-malarial measures.

## 2. Federated Malay States

In the Federated Malay States at Klang and Port Swettenham, very satisfactory results have been obtained. Here the measures adopted were extensive drainage of swamps, mechanical prophylaxis, that is, making the houses mosquito-proof by means of wire gauze, and quinine distribution.

The following tables give some of the results:

1. *Cases of malaria admitted to Klang Hospital from the two towns, compared with those admitted from the district.*

| | | Anti-malarial measures. | | | |
|---|---|---|---|---|---|
| | 1901 | 1902 | 1903 | 1904 | 1905 |
| Towns of Klang and Port Swettenham... | 610 | 199 | 69 | 32 | 23 |
| District ..... | 197 | 204 | 150 | 260 | 353 |

There is thus a fall from 610 in 1901, when the anti-malarial campaign was instituted, to 23 in 1905, while an increase took place among those from outside.

2. *Deaths in Klang and Port Swettenham.*

| | 1900 | 1901 | 1902 | 1903 | 1904 | 1905 |
|---|---|---|---|---|---|---|
| Fever ..... | 259 | 368 | 59 | 46 | 48 | 45 |
| Other causes ..... | 215 | 214 | 85 | 69 | 74 | 68 |

3. *Deaths in District excluding Towns.*

| | No anti-malarial measures. | | | | | |
|---|---|---|---|---|---|---|
| | 1900 | 1901 | 1902 | 1903 | 1904 | 1905 |
| Fever ..... | 173 | 266 | 227 | 230 | 286 | 351 |
| Other diseases ..... | 133 | 150 | 176 | 198 | 204 | 271 |

*Sick Certificates and sick leave granted to Government employés:* (Number 176 in 1901 and 281 in 1904).

| | | Anti-malarial measures. | | | |
|---|---|---|---|---|---|
| | 1901 | 1902 | 1903 | 1904 | 1905 |
| Certificates ..... | 236 | 40 | 23 | 14 | 4 |
| Days of leave ..... | 1,026 | 198 | 73 | 71 | 30 |

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| Certificates ..... | 236 | 46 | 23 | 14 | 4 |
| Days of leave ..... | 1,026 | 198 | 73 | 71 | 30 |

Dr. Watson, the Medical Officer, makes an important remark regarding the reduction of mosquitoes: —'A definite improvement in the health of Klang was evident *when only the swamps nearest to the main groups of houses had been dealt with*, and while other swamps within the town were still untouched. The mosquitoes from these did not appear to travel any distance, and there has been no evidence of dangerous immigration of Anophelines from the extensive breeding places which, until the middle of 1904, existed just outside the town boundary, and some of which still remain. Yet the species breeding in those swamps were identical with those breeding in the town.'

## 3. Hong Kong

In Hong Kong an anti-malarial campaign, drainage, wire gauze, oiling the pools and quinine prophylaxis, was started by Dr. Thompson in 1901, and here it must be remembered that owing to the constant daily migration of 3,000 to 6,000 natives from the country districts, the difficulties of stamping out malaria are much greater, as many of these must remain infected in spite of local measures. But in spite of this the malaria reduction is very striking.

Malaria statistics in two large hospitals.

| | | | | | | | Anti-malarial measures | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1896 | 1897 | 1898 | 1899 | 1900 | 1901 | 1902 | 1903 | 1904 | 1905 |
| Admissions ..... | — | 1,021 | 865 | 780 | 1,220 | 1,294 | 752 | 568 | 433 | 419 |
| Deaths ..... | — | 197 | 126 | 63 | 163 | 132 | 128 | 63 | 58 | 54 |

Admission rate of Police for Malaria.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Admissions per cent. | 32 | 25 | 19 | 31 | 42 | 44 | 19 | 18 | 11 | 12 |

Deaths from Malaria.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Population ..... | 239,419 | — | — | — | — | — | — | — | — | 377,850 |
| Total deaths..... | 533 | 554 | 530 | 546 | 555 | 574 | 425 | 300 | 301 | 285 |
| Deaths in city (Chinese only) | 290 | 302 | 280 | 218 | 242 | 281 | 189 | 152 | 90 | 87 |

## 4. Sierra Leone

Here, as the difficulties of immediately dealing with the town were great, the principle of segregation was adopted. A cantonment was constructed on the hills away from native dwellings, with the result that malaria has entirely disappeared among the resident European Government officials. Among Government officials elsewhere, quinine prophylaxis has been carried out with beneficial results.

In the city of Freetown, an intensely malarial place, the three main streams which were prolific sources of Anophelines have been canalised, resulting in a marked diminution in the number of mosquitoes. Oiling of the pools was also extensively resorted to, and a clause rendering it a punishable offence to have mosquito larvae in the compounds was passed. Unfortunately it is very difficult to get the native municipality, who control local sanitation, to move in the matter, and progress is very slow.

## 5. Italy

Some parts of this country are among the most malarious in the world, as many as 11,000 deaths formerly taking place in the year, and the difficulties were very great owing to the enormous tracts of country to be dealt with, and the nature of the agricultural cultivation. Thus, though drainage and agrarian sanitation were carried out, it was found difficult to proceed rapidly with this on a large scale, owing to the great expense involved. But while it was recognised that the ultimate aim must be the reduction of the Anopheline Mosquito by means of agrarian sanitation, it was found that an incalculable saving in health and life could in the meantime be effected by other means, namely, firstly, by methods of *mechanical prophylaxis*, that is by protecting the individual from the bite of mosquitoes, and, secondly, by *medical prophylaxis*, that is by the preventive use of quinine, and it is in Italy that perhaps this method has been most extensively and thoroughly carried out.

The following table shows the effect of *mechanical* prophylaxis alone, which was carried out along the Italian railways: the first column showing the percentage of fever attacks among people protected, the second among those not protected. The difference is striking:—

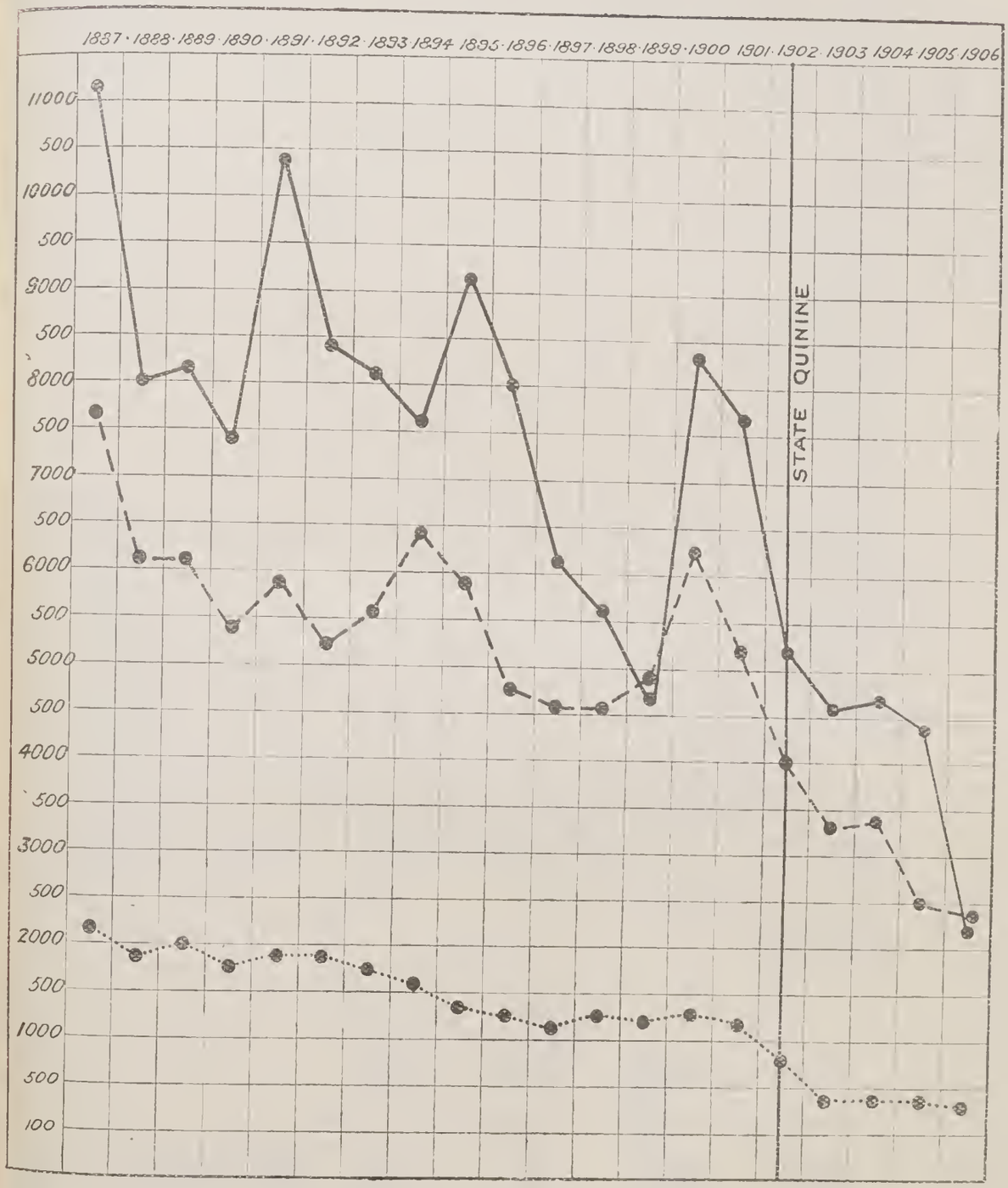
Mechanical Prophylaxis along the Statien Railways

| Year | Persons protected | Percentage attacked with fever | | Percentage of control attacked | |
|---|---|---|---|---|---|
| | | Recurrent | Primary | Min. | Max. |
| 1899 | 24 | 20·0 | 20·0 | 96 | — |
| 1900 | 27 | 5·5 | 7·5 | 77 | 92 |
| 1901 | 5,165 | 3·3 | 20·2 | 20 | 96 |
| 1902 | 5,851 | 10·1 | 2·0 | 12 | 81 |
| 1903 | 8,230 | 22·5 | 4·6 | 10 | 32 |
| 1904 | 12,378 | 8·7 | 2·0 | 10 | 27 |

But clearly, mechanical prophylaxis was applicable only to a limited number on account of the expense, and hence it was found that in Italy the method which was capable of most general application and most efficient was the *distribution of quinine*, and here it is undertaken entirely by the State, distributed gratuitously to those who are too poor to pay for it, and sold at cost price to those in a better social position.

The following diagram shows the mortality from malaria in Italy before and after the commencement of State distribution of quinine.

It will be observed that the mortality from malaria is subject to periodical oscillations, with a maximum every five or six years, but that on only one occasion, from 1887 to 1902 (the year when quinine distribution was begun), in Latium and South Italy alone did the mortality sink below 5,000, while in two years it was over 10,000. *After* 1902, however, it never rose as high as 5,000, and in 1906 was under 2,500, an enormous annual saving of human life, and, further, the periodic rise which was due in 1905 or 1906 did not occur.




Mortality from Malaria in Italy before and after State distribution of quinine.

———— Latium and South Italy.

– – – – – – Sicily and Sardinia.

. . . . . Central Italy (excluding Latium and North Italy).

A similar result is shown in the following table:—

Quinine Prophylaxis in the Agro Romano

| | 1900 | 1901 | 1902 | 1903 | 1904 | 1905 | 1906 |
|---|---|---|---|---|---|---|---|
| Prophylaxis in the Agro Romano ..... | 79 | 1,176 | 3,853 | 17,506 | 29,693 | 38,429 | 41,072 |
| Primary infections treated by the Red Cross Society | 1,716 (17) | 1,263 (13) | 764 (7) | 320 (2) | 162 (1·34) | 250 (1·52) | 129 (0·7) |
| Malarial patients treated by the Red Cross Society | 3,751 (31) | 2,366 (26) | 2,581 (20) | 1,547 (11) | 1,406 (10) | 839 (5·1) | 576 (3·4) |
| Malarial patients admitted into the Rome hospitals | 6,186 | 4,725 | 2,750 | 2,461 | 2,991 | 3,991 | 2,513 |

The figures in parentheses are the percentages.

With the increase of people taking quinine as a preventive in the Agro Romano the number of primary infections treated by the Red Cross Society fell from 17 per cent. to 0·7 per cent., and the number of malarial patients treated by the same Society from 31 to 3·4 per cent., while the number of patients treated in the Rome hospitals for malaria fell from 6,186 to 2,513, representing a large saving in hospital expenditure.

Among Government officials, who can be controlled with greater facility, the percentage of cases of malaria has fallen, in the case of employés on the railway, from 69·92 to 19·84, owing to the introduction, first of mechanical prophylaxis, and later the addition of the quinine prophylaxis.

Malaria along the ex-Adriatic Railways

| Year | Percentage of cases of malaria | Days of mean duration of cases of malaria | Mean of days of illness lost every year per person | Observations |
|---|---|---|---|---|
| 1888-1905 | 69·92 | 7·88 | 5·48 | Without prophylaxis |
| 1902 | 44·93 | 6·99 | 3·12 | Mechanical prophylaxis |
| 1903 | 30·32 | 6·25 | 1·89 | ,, ,, |
| 1904 | 33·10 | 7·33 | 2·48 | ,, ,, |
| 1905 | 39·44 | 7·64 | 3·01 | ,, ,, |
| 1906 | 19·84 | 8·52 | 1·69 | Mixed prophylaxis |

Similarly among Customs House officers the percentage of cases of fever has fallen from 65·30 to 12·73 by mechanical prophylaxis alone, and further to 7·30 by the addition of quinine prophylaxis.

Malaria in the Customs House Officers

| Year | Number of Customs House Officers | Cases of fever verified | Percentage | Observations |
|---|---|---|---|---|
| 1900-1902 | 1,738 | 1,035 | 65·30 | Without prophylaxis |
| 1903 | 1,751 | 222 | 12·73 | Mechanical prophylaxis |
| 1904 | 1,714 | 209 | 12·19 | " " |
| 1905 | 1,721 | 187 | 10·86 | Mechanical prophylaxis and beginning of quinine prophylaxis |
| 1906 | 1,614 | 118 | 7·31 | Mechanical and chemical prophylaxis |

These striking results have been obtained largely by means of State legislation. A series of laws have been promulgated giving the public the right to buy quinine at a minimum price, imposing upon employers the duty of preventing the damage done by malaria by giving the preventive quinine gratuitously to workers, and of compensating them by giving them the curative quinine gratuitously, and giving the *poor* the right to have quinine given them gratuitously by the charitable institutions.

And the net results are shown in the following Table:—

State Quinine and Mortality from Malaria

| Consumption of state quinine | | Mortality from malaria | | Net profits of administration of State quinine in lire |
|---|---|---|---|---|
| Financial year | Kilograms sold | Solar year | Total deaths | |
| — | — | 1895 | 16,464 | — |
| — | — | 1896 | 14,017 | — |
| — | — | 1897 | 11,947 | — |
| — | — | 1898 | 11,378 | — |
| — | — | 1899 | 10,811 | — |
| — | — | 1900 | 15,865 | — |
| — | — | 1901 | 13,861 | — |
| 1902-3 | 2,242 | 1902 | 9,908 | 34,270 |
| 1903-4 | 7,234 | 1903 | 8,513 | 183,039 |
| 1904-5 | 14,071 | 1904 | 8,501 | 183,382 |
| 1905-6 | 18,712 | 1905 | 7,838 | 293,395 |
| 1906-7 | 20,723 | 1906 | 4,871 | 462,290 |

On this Professor Angelo Cello remarks that 'It appears that the 'annual consumption of State quinine has progressively increased 'from 2,242 to 20,723 kilogrammes (4,941 to 45,673 lbs.), and that in 'the respective quinquennia the mortality from malaria has progres- 'sively diminished two-thirds.

'This intimate relation between the progressive increase of the 'one, and the progressive diminution of the other, cannot honestly be 'ignored or denied.

'In fact from 1887 to the end of 1895 upwards of 15,000 persons 'died annually from malaria. . . . . Owing to the introduction 'and the continuously increasing diffusion of the State quinine, the 'mortality from year to year has rapidly fallen to less than 5,000 'victims, and the characteristic periodic recrudescences have no longer 'presented themselves.

'Now who can deny to-day that quinine is not the sovereign 'remedy, and that only those die from malaria who do not take it in 'time and in sufficient quantity?'

Concurrently with these measures a wide propaganda as to the causes and prevention of malaria has been made by means of the distribution of handbills, pamphlets, and by giving lectures and demonstrations. In other words, a serious effort has been made to *educate* the public as to evils of malaria and the means of mitigating the scourge.

### 6. The Panama Canal

To come a little nearer home, the work which has been done at Panama by the Americans is a striking lesson of what can be done by systematic and prolonged efforts on a scientific basis, by a strong Government, under climatic conditions which approximate very closely to those which obtain in the Island of Jamaica.

The measures adopted here have been the formation of a Mosquito Brigade which undertakes the cleaning of ditches, filling up swamps and holes, cleaning of pools, oiling of ditches, pools, etc., making of cement gutters, screening of houses, etc. No fewer than 2,674 lbs. of quinine were distributed.

The results, for which I am indebted to the courtesy of Professor

Sir R. Boyce, are given by Colonel Gorgas, the able and distinguished Medical Officer in charge of the Sanitary Department, as follows:—

Death rate among employés

| Year | Force | Deaths | Rate per 1,000 |
|---|---|---|---|
| 1906 | 26,705 | 1,105 | 41·37 |
| 1907 | 39,343 | 1,132 | 28·77 |
| 1908 | 43,890 | 571 | 13·01 |

The death rate among the black employés has fallen as follows:—

| Year | Force | Deaths | Rate per 1,000 |
|---|---|---|---|
| 1906 | 21,441 | 1,083 | 47·24 |
| 1907 | 28,634 | 953 | 33·28 |
| 1908 | 31,507 | 402 | 12·76 |

This means that in 1906 out of every 1,000 blacks on the rolls, 47 died, while in 1908 only 12 died, that is to say one-quarter of the deaths.

Among the total population of Panama, Colon and the Canal Zone, the deaths were as follows:—

| Year | Population | Number of deaths | Rate per 1,000 |
|---|---|---|---|
| 1906 | 66,011 | 3,544 | 49·10 |
| 1907 | 102,133 | 3,435 | 33·63 |
| 1908 | 120,097 | 2,983 | 24·83 |

That is to say, in 1908 the death-rate was *half* what it was in 1906.

In 1906 there were 233 deaths; in 1907, 154 deaths; in 1908, 73 deaths. That is with a force more than one-third larger, there were in 1908 one-third fewer deaths from malaria than occurred in 1906.

Colonel Gorgas remarks:—'I consider malaria the best measure of the sanitary work done. In 1906 out of every thousand employés we admitted in our hospitals from malaria, 821; in 1907, 424; in 1908, 282; that is, we now have only about one-third the amount of malaria among our employés that we had three years ago.'

## 7. Havana.

Although the following figures do not refer to malaria, they are of great importance as showing the effect of anti-mosquito measures, in the diminution of yellow fever, to an outbreak of which Jamaica

is at any moment liable, as there is an ample supply of the yellow fever mosquito, the Stegomyia, available all over the Colony.

Deaths in Havana from Yellow Fever.

| Year | Deaths | Year | Deaths | Year | Deaths | Year | Deaths |
|---|---|---|---|---|---|---|---|
| 1871 | 991 | 1881 | 485 | 1891 | 356 | 1901 | 18 |
| 1872 | 575 | 1882 | 729 | 1892 | 357 | 1902 | 0 |
| 1873 | 1,244 | 1883 | 849 | 1893 | 496 | 1903 | 0 |
| 1874 | 1,425 | 1884 | 511 | 1894 | 382 | 1904 | 0 |
| 1875 | 1,001 | 1885 | 165 | 1895 | 553 | | |
| 1876 | 1.619 | 1886 | 167 | 1896 | 1,282 | | |
| 1877 | 1,374 | 1887 | 532 | 1897 | 858 | | |
| 1878 | 1,559 | 1888 | 468 | 1898 | 136 | | |
| 1879 | 1,444 | 1889 | 303 | 1899 | 103 | | |
| 1880 | 645 | 1890 | 308 | 1900 | 310 | | |

Thus it will be seen that from a large annual mortality from yellow fever in the town of Havana, the mortality fell to *nil*, as the result of systematic, scientific measures directed against the mosquito alone.

But the subsequent history is still more interesting:—

In 1902 the American Governor had handed the Administration over to the Cubans and had left the Island. The sanitary administration evidently then gradually became lax, anti-mosquito measures were not carried out systematically, and in November, 1905, the first case of yellow fever was reported, though it was ascertained that two cases had occurred in October. A short epidemic followed, and by the middle of February, 1906, 72 cases with 23 deaths had occurred, and up to June 30th, 1906, 82 cases with 28 deaths.

But in 1907 the United States again took over the Government, and the following passage occurs in the Annual Report of the Public Health and Marine Hospital Service for 1907.

'Following a resolution, the administration of Cuban affairs again 'devolve upon the Government of the United States. From a 'sanitary point of view this transfer was significant. There had been 'laxness in sanitary work in the interior, and many districts had 'retrograded to deplorably unhygienic conditions, requiring attention. 'Among the first undertakings of the new regime was the creation 'of an efficient sanitary service, supervised by an officer of the Army 'Medical Department. . . . . The benefits have been promptly shown 'in the elimination of yellow fever from Havana.'

In the interior of the Island, after its re-introduction in 1905, Yellow Fever continued to spread, and this was attributed to the 'great lapse in Sanitation,' and the lack of hearty co-operation on the part of native Cubans. Consequently 'an act was promulgated 'in August, 1907, nationalizing the Sanitary Service, abolishing 'Municipal Boards, and placing public health affairs in charge of a 'central body, presided over by the Chief Sanitary Officer,' and no doubt in the Annual Report for 1909 the effect will be apparent.

In Havana, the result of the new Sanitary administration has been at once apparent, as shown in the following statistics :—

| | Cases of Yellow Fever | Deaths | Percentage |
|---|---|---|---|
| Year ending 30th June, 1906 ... ... | 82 | 28 | 34 |
| ,, ,, 1907 ... ... | 61 | 9 | 15 |
| ,, ,, 1908 ... ... | 9 | 1 | 11 |

The necessity of continuity, system, and permanence in Sanitary administration, to which I shall draw attention later, is here exemplified in the most striking manner.

## IX. ANTI-MALARIAL MEASURES IN JAMAICA

### Measures Already in Force

The first question is, what steps have already been taken in the direction of the Prevention of Malaria, and an inquiry showed that these are practically *nil*. The following replies from the District Medical Officers give the results :—

Stoney Hill : 'No anti-malarial measures are taken in this district.'

Morant Bay : 'Nets used by the better classes. Some families take some care in dealing with possible breeding places for mosquitoes. No general preventive measures have been adopted.'

Hordley : 'None, so far as I am aware.'

Port Antonio : 'No anti-malarial measures taken by the Local Sanitary Authorities. Mr. Mitchell has filled in ten acres of morass privately.'

St. Ann's Bay : 'Beyond drainage, no anti-malarial measures have been taken in the district.'

Cave Valley: 'No special anti-malarial measures have been taken in this district.'

Falmouth: 'No anti-malarial measures have been taken in this district.'

Savanna-la-Mar: 'Very little care is taken by any section of the community to protect themselves from malaria. Mosquito nets are in fairly universal use.'

Mandeville: 'Fever does not exist or arise in my district except as an occasional sporadic case at Porus. (!) Therefore there are no anti-malarial measures necessary.'

Chapelton: 'No anti-malarial measures are taken.'

Kingston: 'No anti-malarial measures have been taken.

Lucea: 'No special anti-malarial measures have been taken beyond the usual routine of quinine administration and advice to patients to use bed netting.'

Black River: 'None taken.'

Buff Bay: 'Anti-malarial measures taken in the district:—

(*a*) Swamps in various parts of the town and district have either been drained or filled up.

(*b*) Concrete drains have been laid in the principal streets.

(*c*) Quinine has been distributed to the indentured immigrants on all the estates in my district.'

Annotto Bay: 'The anti-malarial measures taken in the district are few and unsatisfactory. Quinine is supplied to the estates for indentured immigrants. This, however, as a prophylactic, has not been given a fair trial. The use of mosquito nets is limited to a very small percentage of the population.'

## Preventive Measures Recommended

### *Preliminary Observations.—Financial*

Before considering the practical measures of anti-malarial sanitation, it is advisable to make one or two preliminary observations.

And first of all, it would be useless making recommendations which are clearly beyond the financial capabilities of the Colony; all

measures must be limited to the amount of money which is available. It would be futile, for example, to advise extensive engineering schemes which, though theoretically correct and advisable, would involve the immediate expenditure of thousands of pounds, or at any rate, of amounts which could not be obtained without crippling the financial resources of the Colony for many years, and might not be obtainable at all. Obviously then our aim must be a compromise between the demands of theory and the exigencies of actual circumstances, and the results attained in Italy afford a very good example of what may be done by keeping this in mind.

### *Agricultural*

Similarly, as malaria has been shown to be dependent to some extent in this Colony upon the agricultural methods, it would be useless to suggest measures which would involve hampering or perhaps putting a stop to the agricultural development which is at present such a striking feature of some parts of Jamaica. If the eradication of malaria means the giving up of banana plantations, for example, or of imposing too great a burden on them, I am afraid that, not only the planters but the public generally, will shrug their shoulders and say, 'Well, we must put up with the malaria, we must recognise a certain amount of inefficiency from sickness, and we must provide for a certain toll on human life.' The progress of Jamaica is dependent upon its agricultural development, and the methods adopted must assist, not interfere, with this. And if I can show that, by slight modifications of these methods, by the adoption of comparatively simple precautions, necessitating, no doubt, thought, supervision and perseverance, a very great improvement can be effected, I am convinced that the common sense and business-like qualities of the estate owners will lead them to adopt the necessary measures, and I think the Government will be justified in calling upon them to do so.

### *Government*

Then it must be observed that all measures will fall naturally into two classes, namely, (*a*) those which must be undertaken by the Government, or a municipality, or a parochial board, or some organisation possessing funds at its disposal, and (*b*) those which are

more or less personal, and must be undertaken by the individual. Among the former would come such major works as drainage, the filling up of swamps, and the local arrangements and organisation for carrying out the measures detailed below. And it is essential that this body should form some definite plan of campaign which, once formed, would be continuous and systematic, and would not be liable to alteration by conflicting local interests or petty jealousies. Perseverance, continuity, and permanence are essential.

This will undoubtedly require legislation in certain directions, and in framing legislative measures in connection with sanitation, it is necessary that they should be as simple as possible, and as little burdened with legal technicalities and machinery as practicable.

In my experience of the Tropics, I have seen admirable measures rendered a dead letter through the difficulty of readily and easily bringing offenders within the meshes of the law, and if such measures are to be practically effective we must ask for, and I am sure we shall obtain, the whole-hearted co-operation of the magistracy.

To the share of the Government or central body will also fall the duty of collecting data with reference to malaria, receiving reports, and noting results. There must be some method of observing the effect of the different measures, and the central body will thus be able to control the expenditure, diminishing it where improvement has been effected, and increasing it where required.

### *Personal*

As regards (*b*) the measures to be undertaken by individuals, this will resolve itself largely into a question of personal hygiene. As in all sanitary schemes, certain work is laid upon the individual, so it must be in anti-malarial sanitation. The individual must not be allowed to be a danger to the community by harbouring Anopheline larvae in his compound any more than he would be allowed to conceal a case of smallpox, and employers of labour must either personally, or by means of their overseers, see that the measures decided on are effectively carried out.

## Practical Measures against Malaria

Now we come at last to a consideration of the practical measures which are especially applicable to Jamaica, many of which have already been incidentally mentioned.

And these, as I have already shown, will depend upon two factors

(*a*) the infected mosquito, and

(*b*) the infected individual.

(*a*) **Mosquito reduction:** It is evident that in a well watered island like Jamaica, with large areas under cultivation, it is out of the question to hope for the complete extermination of the mosquito. But this is not necessary: a *reduction* in the number of mosquitoes is sufficient, and this can be effected with little difficulty.

I do not propose here to enter into a discussion of the factors which govern the numbers and diffusion of Anophelines in any given locality, but would refer those who wish to study this part of the subject more minutely to other scientific papers, and especially to Professor Ross's Report on Malaria in Mauritius. But it is self-evident that the further off a breeding place is from an inhabited locality, the fewer mosquitoes will reach the inhabitants of that spot. If we have two pools in the neighbourhood of a town, A at 50 yards breeding, say, 100 Anophelines, and B at 100 yards breeding the same number, if we can so treat breeding pool A that the Anophelines do not breed there, we have diminished very largely the probabilities of Anophelines reaching the inhabitants from the distant breeding pool B. So that the problem does not involve the destruction of mosquitoes over large areas, but resolves itself into their extermination or reduction in the immediate vicinity of inhabited places; and it has been shown by practical experience elsewhere (see note on Federated Malay States) that mere *reduction* is sufficient to cause a large diminution in the amount of malaria. And if to these we add a reduction in the number of infected individuals by various means, we get a still further proportionate diminution in the amount of malaria.

(1) **Rivers and Swamps.** The first step, and the most important as affording eventually a permanent solution of the problem, is of course the *drainage and filling in of swamps* in the immediate vicinity of towns. Most of the principal towns are situated at the mouth of rivers, and consequently are surrounded by swamps. But I recognise that this is a very large engineering question, and if an attempt were made to overtake it at once, would involve an expenditure of public money which is out of the question. So that

I do not advocate any extensive attempt to do this at once. But I do suggest that each town should undertake the *gradual* filling up the swamps in its immediate neighbourhood. A special portion of the swamp should be selected and all town rubbish should be deposited in such spots.

In some places this has been done with great benefit, for example, at Port Antonio a considerable area of the swamp has been filled in to form a cricket ground, and a piece of ground, which formerly supplied thousands of mosquitoes, is now solid ground—a most excellent piece of reclamation. At Folly Point, too, by the enterprise of a private individual, Mr. Mitchell, a considerable area of ground has been reclaimed; and I understand he was anxious to do more on a piece of land which was not his own property, but was unable to obtain permission from the owner. This is regrettable, and I think that in such cases private idiosyncrasies should not be allowed to stand in the way of public improvements. At Annotto Bay, too, a gentleman, Mr. Westmoreland, is depositing his cocoa-nut refuse on a swamp at one side of the town, which will eventually have the effect of reclaiming this portion. These are examples of the object to be kept in view, constant and *systematic* filling up of the swamps, and if the supervising boards will carry this out much will be done. But it must not be haphazard, it must be *continuous*.

But while this is going on other palliative measures can be adopted. Where there is a tendency for the sea to back up the outlet of the river, an endeavour should be made to keep it open. This will reduce the area under water behind, and, if regularly done, should not involve much expenditure.

Then, I have already pointed out that the Anophelines breed in shallow water where there is grass and weeds. Therefore, *clear out the grass and weeds*, and especially at the edges. A great improvement can be effected by deepening the pools at the edges, and making a square margin with rough stones. This should not be costly near the beach, where stones are available.

Where the area of swamps is considerable, with scattered pools, a trench or two will be found beneficial. A trench collects the water and is more easily kept clean and treated than a large area.

In some instances it may be practicable to admit salt water to pools or trenches where the level is low. The possibility of this

should be remembered, as Anophelines, with very rare exceptions, do not live in salt water.

So far as rivers themselves are concerned, the only dangerous parts are the shallow grass-grown edges. These should be deepened where practicable, and in any case cleared of weeds. Of course I am referring solely to the parts in the immediate vicinity of towns and villages. The rivers and streams in country districts need not be dealt with. Where small shallow streams run through towns, they must be *canalized*, so as to confine the water to a limited area during the dry season. During the rains, when the current is strong, they are not dangerous.

But there is another method which is very effective in pools and all standing water, and which should always be adopted *in addition* to the above measures. I refer to the *oiling* of the surface of the water with crude kerosene. Larvae have to come to the surface to breathe—cover the surface with a thin layer of kerosene oil and they are suffocated. This alone will produce an enormous diminution in the number of Anophelines. It is especially applicable to Annotto Bay, where the pools are extensive and situated right in the middle of the town. Crude kerosene is cheap and it is very easily applied. A long stick with a few rags on the end, or a whitewash brush dipped in a tin of crude kerosene and then splashed on the surface of the water, will form a film over a large area, and one man could oil the whole of the pools in a single day. As the larvae take, on an average, from five to seven days to breed out, oiling twice a week would be sufficient. I am informed by Dr. McCatty, a very enthusiastic and keen advocate of anti-malarial measures, that the Parochial Board of Montego Bay have obtained a supply of crude kerosene, and that oiling the pools is to be extensively carried out.

(2) Treatment of **shallow ditches and gutters.** In towns, wherever it is possible, these should be cemented as is being done in Montego Bay, Savanna-la-Mar, and other places. A cemented gutter is easily kept clean. But this work, of course, will be gradual, and in the meantime they must be kept free from grass and weeds, and regularly oiled. The bottom should, so far as possible, be levelled so as to allow of an even flow of water.

(3) **Cattle ponds** caused by surface drainage. As a rule, these are not in the immediate vicinity of dwelling-houses, and in such

cases need not be troubled about; but when they are, they should be dealt with on similar lines. Clear away all grass and weeds, deepen the edges, and where possible form small embankments. Use kerosene oil when the water is not used as a water supply. In certain waters larval-feeding fishes, 'ticky-tickies,' &c., are to be found. These should be encouraged and protected as far as possible, but they are a less reliable defence than oil.

(4) **Accidental and temporary pools.** These should be filled up with earth or stones where possible; if not, oiled twice a week.

(5) **Wells.** These should be kept clean and free from growths round the edges, and in addition should be screened by being provided with a wire gauze cover. It should also be made compulsory to screen all barrels, tanks and other receptacles for storing water, as these breed other and harmful varieties of the mosquito.

(6) Now we come to **drainage trenches** in banana plantations, and I have already indicated the treatment. Keep them free from grass and weeds, and oil where necessary. The oil will not harm the bananas, and cleaning the trenches will benefit them. On each estate there should be at least one 'mosquito' coolie, whose sole duty it should be to oil, and to report on all mosquito-breeding places. It is very simple to teach him to recognise the haunts of the mosquito, and an energetic 'busha' will have no difficulty in knowing when the work is being thoroughly done.

(7) **Irrigation canals.** All that can be done is to keep the canals clear of weeds, to so plan them than the gradient is even, and treat outlying pools with kerosene.

## Legislation

But these public measures will be hampered and to some extent neutralised if private individuals are to be allowed to breed mosquito larvae in their compounds. I regard it, then, as imperative, that **legislation should be introduced without delay,** making it a punishable offence to have mosquito larvae in any collection of water in a compound, that is to say, this particular insanitary condition should be placed in the same category as any ordinary 'nuisance,' which at present can be dealt with by law. No doubt opposition will be

raised to this. We shall hear about the hardship to the poor native and of his inability to recognise mosquito larvae, his ignorance of the evil results which may follow, and so on, but experience has shown elsewhere that these difficulties are not met with in practice. Every native is familiar with the 'wriggler' in water, though he may not be aware that it develops into a mosquito, and when he realises that the presence of a barrel full of 'wrigglers' in his yard entails a compulsory visit to the police court, and the production of a certain sum of money, we may rest assured that they will disappear like magic. And it is not as if the suggestion involved any expense: all that is required is supervision on the part of the occupier, the frequent emptying of water barrels and other vessels, the daily sweeping out of hollows in the ground, and the cleaning of gutters. It will not be contended that this places a serious burden on the householder.

And though the suggestion may be unfamiliar to Jamaica, and possibly therefore somewhat unpalatable, it is by no means a new one. I was successful some years ago, in Sierra Leone, in getting a clause included in the Sanitary Ordinance, making it a punishable offence to have mosquito larvae in a compound, and similar laws have been passed in other West Indian colonies, and are actually being put in force. Sir R. Boyce, who has just returned from visiting the other colonies, informs me that prosecutions are being daily undertaken, and that fines of no less than £2 are being inflicted, with the most beneficial results in diminishing mosquitoes.

A very appreciable diminution in mosquitoes can then be effected by simple means, the principal cost at first being (*a*) cost of kerosene, and (*b*) wages of a sufficient number of men (which need not be great) to oil and keep down the grass and weeds. I would therefore summarise the anti-mosquito measures as follows: not in the order of their importance but of their practicability:—

**1. Make the harbouring of mosquito larvae in private compounds a punishable offence.**

**2. Keep all margins of rivers, swamps, water channels, ditches, gutters, ponds and pools free from grass and weeds.**

**3. Apply crude kerosene regularly to all possible breeding places of mosquitoes.**

4. Cement all gutters in towns.

5. Screen all wells, tanks, barrels, etc.

6. Gradually reclaim and drain swamps in the immediate vicinity of towns.

### Preventive Measures affecting the Individual

We can prevent the *individual* from becoming infected by protecting him from being bitten by mosquitoes already infected; and we can prevent the *mosquito* from becoming infected by placing obstacles in the way of his biting individuals already infected, and thus becoming infected in his turn. We thus diminish two sources of danger.

The measures to be adopted come under the head of Mechanical Prophylaxis, and are mainly a matter for *personal* application: —

1. **Use of the mosquito net.** As the habits of the Anopheline mosquito are mainly nocturnal, it follows that if we protect ourselves from the bites of these animals during the time we are in bed, say from ten to six, that is to say, for eight hours out of the twenty-four, we are protecting ourselves for a third of our lives, and that, at the time when we are most defenceless and liable to attack; and yet I was astonished to find that in Jamaica the use and value of the mosquito net was so little appreciated, and that its use was not carried out in a satisfactory and efficient manner. I can only recall one single instance in which it was properly used, that is, hung inside the mosquito poles, so as to permit of its being tucked underneath the mattress.

Occasionally, when I suggested the use of the mosquito net, I was met by the answer, 'Oh, there are not many mosquitoes here, and they don't touch me.' But *one* infected mosquito is sufficient to do the mischief, and surely, apart from comfort, an elementary precaution of this kind should not be neglected, especially in the hotels. I was assured in one hotel that there were no mosquitoes, but I was kept awake for some hours, until apparently all those in the room had had sufficient nourishment, when I succeeded in falling into a troubled slumber.

The use of the mosquito net, then, as a personal protection in malarious localities, is one which should *never* be neglected by those able to afford it.

But obviously this measure is one of limited application. The mass of the general native population cannot provide themselves with mosquito nets on account of the expense, nor can it be expected that the Government should do so.

2. The same consideration applies to some extent to the next method, the use of houses or rooms made **mosquito proof** by means of wire gauze. This is undoubtedly one of the most effective of the methods of mechanical prophylaxis, and has been adopted extensively in Italy, and to some extent in West Africa and other highly malarious parts of the world. It is out of the question applying it generally, but there are certain directions in which its use would be of value, and would eventually result in an economy to the Government.

*Police Stations*

Among these, Police Stations may be mentioned. It has already been tried at Port Henderson, but it should be universally adopted at *all* police stations where the percentage of malarial attacks among the constables is high. These will be readily seen from Table VIII: Morant Bay, Port Antonio, Buff Bay, Port Maria, Annotto Bay, Green Island, Savanna-la-Mar, Black River, Many Pen, Alley, and Old Harbour, as being the most unhealthy, might be among the first protected. The expense of wire gauze is not great, and the beneficial results in increased efficiency would be most marked.

*Public Hospitals*

Another series of public buildings which ought to be dealt with in a similar way in certain localities are the Public Hospitals, and I observed in the Medical Report for 1908, that provision has been made in the estimates for doing this to some extent. In Annotto Bay, for example, it is almost criminal to collect and house, in open wards, or worse still in tents, in the middle of a populous town, malarial cases from all parts of the district, with an extensive Anopheline breeding pool within a hundred yards. No better device for encouraging the spread of malaria can be conceived, and it is hardly fair that the inhabitants of the place, in addition to their own malaria, should have extraneous sources of infection brought to their very doors.

I observe that the experiment of screening Port Antonio Hospital was tried, but, I understand, was abandoned because the wire gauze was interfered with by the patients. But surely this is a matter for supervision and care.

I venture to think it essential that the Port Antonio Hospital, full of malarious patients (see Medical Reports), situated, as it is, on the ridge on which the hotel and the principal dwellings are built, should be thoroughly screened on account of the danger to the general public.

*Coolie Barracks*

A third situation in which protection by wire gauze should be seriously considered is Coolie Barracks. I am aware that it will be urged that the habits and intelligence of the average coolie will render this difficult if not impracticable, but after all, this is largely a question of custom. At first no doubt there would be damage, but with careful supervision, and as the coolie becomes accustomed to it, I am convinced that the difficulty would disappear.

Even a hundred and thirty years ago the health of employés was a matter of concern to the planters, for I came across, in the History of Jamaica, already quoted, the following pregnant remarks, which are as applicable now as then:—

'Those whom fortune has blest with abundance should be studious 'to preserve the lives of their dependents whose poverty is their 'greatest crime. The cruelty of exposing the lives of men to sickness 'or death by restricting them to live in wretched hovels or in 'unhealthy spots needs only to be pointed out in order to be relieved. 'The natural generosity and benevolent disposition of the planters 'will immediately lead them to administer the certain remedy 'although it may be attended at first with some extraordinary 'expense to them.'

If some public-spirited employer in Jamaica will carry out the experiment thoroughly and will carefully and accurately note the result, I am sure that the striking improvement which will be effected will lead others to follow his example.

There are several minor personal matters, such as anointing the body with various oils or ointments to prevent mosquitoes biting, fumigation of rooms by special preparations, etc., but these are unreliable and not likely to be of general application so that they need not be considered in detail.

3. But there is a third method of prevention as applied to the individual, which is simple, inexpensive, effective and of easy general application. I refer to the **preventive administration of quinine.**

Although the curative effect of quinine, or rather of the bark from which it is extracted, namely cinchona, has been known since the 17th century, attention has only been drawn to its extreme value as a preventive of recent years, but it was evidently well known to the old Jamaicans. 'Strangers newly arrived in such places and those who are constitutionally subject to agues should, during the sickly season, take every other night, two or three teaspoonfuls of tincture sacra or a few grains of pilula rufi, not sufficient to purge but only to keep the body pretty open, and for further prevention a wineglassful of the infusion of bark and orange peel in water, or a tablespoonful of a strong tincture of bark may be taken diluted with water occasionally in the morning before breakfast' (History of Jamaica, 1774).

As far back as 1891 I advocated in the 'Lancet' the daily use of quinine as a preventive, and with every year's residence on the West Coast of Africa I was more convinced of its efficiency, and it was very striking to observe the immunity from malarial fever which was enjoyed by those who took it regularly, as compared with those who did not.

A reference to the section dealing with Italy will show the remarkable results which have been obtained there.

It is sometimes suggested that the long continued use of quinine has a deleterious effect, but as a matter of actual experience this is not found to be the case. On the contrary, the small doses required, generally act as a tonic. Nor does practical experience support the objection that larger doses will be required during the attack of fever if one is habituated to the drug.

Two methods of quinine prophylaxis are recommended, first, the administration of fifteen grains twice a week, and, second, the daily use of five grains. In my experience, the first method, though efficacious, if regularly carried out, is unsuccessful in practice, as it is rarely adhered to. Fifteen grains of quinine will produce in most individuals unpleasant symptoms of cinchonism, headache, buzzing in

the ears, etc.; it is apt to be forgotten and taken irregularly, and is eventually given up. On the other hand, I have had no difficulty in persuading people to take the smaller daily dose and have seen no bad effects from it. The action of the quinine, of course, is its poisonous effect on the malarial parasites, and the immature stages, more especially that which is injected from the salivary glands of the mosquito, appear to be more susceptible than the adult forms, which require larger doses.

I may consider briefly the administration of quinine to different sections of the population:—

### (*a*) *The Police*

Here we have to deal with a disciplined body, under easy control, and the problem is simple. With a force of 1,146 station officers and men in 1908 (according to the figures supplied) a daily dose of five grains would require 4,803 ounces of quinine. At a wholesale cost of 1s. an ounce this would involve an expenditure of £240 per annum approximately if given to every man—considerably less than it costs to keep the men in hospital. But it will not be necessary to administer quinine universally. Many of the stations, as shown in Table VIII, are free from malaria, so that the regular administration of quinine at those stations is not necessary, unless for limited periods, in the case of men transferred from malarious localities. Consequently the cost will be considerably below that stated.

Here, again, a systematic method must be adopted. There should be a daily morning quinine parade at which each man should be compelled, unless exempted by the Medical Officer, to swallow five grains of quinine. This should be done under the personal supervision of the sergeant-in-charge, and the District Inspector should occasionally himself superintend. A Quinine Book, ruled in columns for each day of the month, should be kept, and an entry made opposite the name of the constable. When not taken, a note should be made of the reason for non-administration.

A monthly return should be sent in to the Inspector-General showing the number of doses given, the number of men off duty from malaria, the average daily sick in hospital from malaria, and the proportion of daily sick from malaria to daily strength. This would

afford an accurate comparison between successive months and years.

In cases where men suffer from actual attacks of malaria, they should be kept for considerable periods in hospital, and treated with large doses of quinine for a lengthened time so as to kill all parasites.

Of course, the effect will not be immediate, as so many men are already infected, and recurrences will be frequent, but as these die out, and primary infections are prevented, there will be a marked diminution in the number of inefficients from this cause.

### (*b*) *Indentured Coolies*

Here again we have a body of men who are under definite regulations, and under a certain amount of control, and to whom the preventive administration of quinine should not present any difficulty.

This experiment has already been tried on the recommendation of the Superintending Medical Officer, but evidently it has not been given a fair trial or carried out in a systematic and thorough manner.

I observe in the report for 1907, a number of estates mentioned, with the quantities of free quinine which were issued to them, and I have calculated the amount of quinine which should have been used on one or two.

On Wentworth estate, 46 ounces of quinine were issued. On that estate in 1907 the average daily number of male coolies employed was 31, requiring a daily consumption of 155 grains at five grains per man, or an annual consumption of a little over 129 ounces. 130 ounces at 1s. would cost £6 10s., and even if the malaria could only be diminished by one-third, it would more than repay the cost to the Government.

At Trinity, with an average daily number of 14 men, eight ounces were used instead of 58.

At Low Layton, with 21 men, seven ounces instead of 87; at Amity Hall, with an average of 44 men, 39 ounces instead of 183; at Frome, with 20 men, two ounces instead of 83.

I need not labour this point, but it is quite evident that quinine could not have been regularly given, and unless this is done, it is a sheer waste of money.

A systematic method is here required also.

There should be a morning parade under the personal supervision of a 'busha' or book-keeper; a carefully kept quinine register; and

a record of all absences from work on account of malaria as already suggested. It is useless relying on native Indian overseers, at first at any rate, until they begin to appreciate the benefits, but I am sure it is not impossible to find in Jamaica keen, enthusiastic and energetic 'bushas,' who will see that this method is given a fair and thorough trial.

### (*c*) *School Children*

I have already shown that children are the principal carriers of the malarial parasite, and that the prevalence of malarial infection can be arrived at by ascertaining the percentage of enlarged spleens. It is evident, therefore, that if we can diminish the number of infected children we largely diminish the possibilities of the general infection.

And in the schools of the Colony we can get at the children. In discussing the matter with the Superintending Inspector of Education, he was inclined to believe that the cost of cinchonising the whole school population would be prohibitive. But here, again, we can limit the application. A considerable number of schools are situated in non-malarious districts, and can be excluded, only actual cases of malarial fever in such districts when introduced, being thoroughly treated.

And even in the malarious districts I would, in the first instance at any rate, suggest the limitation of the quinine administration to children with enlarged spleens. Now, this will involve the periodic examination of the school children, and this is one of the recommendations which I have already urged upon the Government. It will then be possible to determine from time to time the number of infected children and the effect of the quinine administration.

The school-master would be supplied with this register, and it would be his duty to administer a daily dose of quinine to all infected children, noting the amount in his register, absences from school, and any reasons for non-administration. No infected child should be exempted, except on a medical certificate.

The cost will be further diminished in the cases of children by the fact that a smaller dose of quinine is required. The daily dose may be approximately as follows:—Up to three years, 1 grain; three to six, 2 grains; six to eight, 3 grains; eight to twelve, 4

grains; and over twelve, 5 grains. In certain cases of immature or undersized children, the dose would have to be lessened, and this would be determined by the Medical Officer. It is a question rather of bulk than of age.

In the case of coolie children not attending school, the administration would be supervised by the 'busha' at the same time as the morning administration to the adult male and female coolies.

As to the form, it is probable that chocolate comfits as issued by the Italian Government will be found most palatable and most readily taken by children.

### (*d*) *General Population*

Here the question is more difficult. We cannot force them to take it but we can place them in the way of getting it readily, and experience elsewhere has shown, that the lower classes very soon learn to appreciate the beneficial results of the quinine, and apply for it freely.

There are three points which experience has taught must be insisted on:—

1st. That it should be given **gratuitously**;

2nd. That it must be brought **directly to the notice** of the people;

3rd. It must be given in **sufficient** quantity.

1. With reference to the first, I quite expect that the objection of 'pauperising' the people will be raised. But the people are already pauperised by malaria. No man (nor woman) can work well with his blood thinned by malaria, and an anaemic pigment-clogged brain. I visited a large number of the peasant dwellings of Jamaica, and it seemed to me that there was a very large amount of real poverty in the Island. Though the people might have enough to eat, of the plainest and most monotonous description, there appeared to be little hard cash, and this view was corroborated by clergymen and others. I must confess to having felt a great sympathy with those unfortunate people in the 'bush,' more especially the women and children, and a great admiration for the patient, cheerful, philosophic way in which they endured their illnesses. There was an uncomplaining fatalism about them which was most pathetic. They looked upon their ills

as dispensations of Providence, which they had not the means to cure, and which must therefore be endured as best they could. And if the gratuitous administration of quinine will alleviate their hardships, I can hardly believe that it will be withheld.

2. The second point is that the supply must be placed in such a position as to be easily available; it must be forced on the attention of the people. It is no use saying that quinine can be had by applying to the Dispenser at Falmouth or Annotto Bay, or any of the other Hospitals. That will serve very well for the inhabitants of the locality; but a woman with fever is not going to tramp five or ten miles for doses of quinine, or if she gets one supply, she will not trouble about the next.

And there is already an identical example of this in the Island in the case of yaws. This disease is very amenable to treatment, and medicine is supplied free. But to be effective, it must be taken continuously, and I found that one bottle would be taken, and then it would be discontinued until the individual happened to be again in the neighbourhood of the supply. Hence the effect is lost, and there is a considerable waste of public money.

3. It must be given in sufficient quantity. In a family of four, for example, father, mother and two children of eleven and seven, say, living in a malarious district, enough must be given to allow them to take 17 grains a day, and it should be carefully explained to them how they are to take it.

To give them half an ounce and to expect it to last a month would be not only useless, as a preventive, but a waste of money.

Consequently some *machinery for distribution* is necessary.

The best method is by the appointment of **Quinine Dispensers** for various malarious districts, whose duties would be to visit the various hamlets, to make house-to-house visitations to find out the people who suffer from fever, to explain the proper method of taking quinine, and to report to the Medical Officer acute attacks of malarial fever. There is no reason why they should not distribute at the same time the medicine for yaws, or for another scourge of the children of the Island, worms.

They would in the first place receive tuition as to the method of administering quinine, the recognition of cases of fever, and of enlarged spleens, and should, I think, be under the control of the

District Medical Officer to whom they would report as to work done, itinerary, cases seen, etc.

An alternative method, but less satisfactory, because it would not include house-to-house visitation, would be to place the distribution in the hands of the clergymen and the police. I am sure that the former would be only to anxious to assist in every possible way, though their time is taken up by many other important duties.

Space will not allow me to go into details as to rules and regulations for such a service, but there are one or two points which I may mention.

In the first place, Government quinine should be in such a form as to render it easily distinguishable from other quinine. If in the form of pills or tablets it may be tinted, but probably the form used in Italy, namely, the tablets of quinine made up with chocolate, would be the most serviceable.

Of course there must be certain restrictions and penalties, and the sale by dispensers or others should be entirely forbidden. But the regulations must be as simple as possible, otherwise too many restrictions will defeat the object of the service, and a certain unavoidable leakage must be allowed for.

As to the well-to-do there is no reason why they should not obtain their quinine from the same sources as they now do.

*Quinine during acute attacks.*

And now a word in passing as to the quinine treatment of fever. I have passed a considerable period of my life in the midst of malaria, often of the most malignant types, and if I may venture a humble word of criticism, I may say that I was much struck with the comparatively small doses of quinine administered during fever in the Island. I am certainly inclined to advocate the administration of considerable doses, 10 to 15 grains, two or even three times a day, according to severity, as being more likely to thoroughly kill off the parasites, and thus limit the period of infection, and as some stages of the parasite are more resistant than others, it is important that quinine in considerable doses should be continued for a considerable time after the febrile manifestations have ceased. Consequently in the cases of police and coolies, they should be kept in hospital for rather longer periods, or some superior officer should see that their doses

of quinine are taken in the quantities ordered by the Medical Officer. By this means recurrences will be rendered less frequent and chronic infections with enlarged spleen will disappear.

## X. ANTI-MALARIAL ORGANISATION

I have thus gone somewhat fully into the preventive measures which experience has shown to be beneficial as regards the reduction of malaria, and have indicated those which are specially applicable to Jamaica; and the question of the machinery by which they are to be carried out must now be considered. If any plan of campaign is to be carried out persistently and systematically, some form of organisation must be provided, and this applies equally to the war against disease. Our efforts must be properly directed if they are to be effective.

But the machinery must not be complicated or expensive, and the following brief sketch indicates the lines which in my opinion should be followed.

1. First there should be a **Central Malarial Board** to sit in Kingston. It should consist of members from various localities, and the medical profession should be largely represented on it. No doubt the secretarial work of the Board could, with advantage, be done by the Medical Department.

The Board would formulate a plan of campaign, consider the works and methods to be adopted in various localities, estimate cost, consider the legislation required, and receive and collate all statistics and reports as to work done.

2. **Local Boards** to report and recommend to Central Board, and to carry out the measures decided on. Their Medical Officer should be *ex-officio* a member of the Local Board.

3. **Staff of Local Boards :—**

(*a*) Medical Officer. The question as to whether this work can be carried out by the District Medical Officer will have to be considered. In some districts it would be an advantage, in others it seems to me that their time is already so much occupied with other duties that they would be unable to give the necessary supervision. The duties of the Medical Officer would be general inspection of the malarial district, general supervision of the men, medical examination

of children (splenic census), periodical visits to the schools, collection of statistics as regards malaria, and preparation of reports as to work done and results. This sounds extensive, but a good deal of the work is overlapping.

(*b*) Mosquito gangs: These would vary in size according to locality, and would be controlled by a headman of intelligence, of whom there is no lack in Jamaica. It is important that they should have a distinctive badge, and that their authority should be upheld and respected.

Their duties would be principally:—

1. Clearing pools and swamps of weeds.
2. Deepening shallow pools and swamps where feasible.
3. Filling up depressions.
4. Oiling collections of water.
5. Inspecting yards.
6. Serving summonses for contraventions.

(*c*) Quinine Dispenser: Duties already detailed.

## XI. COST

I have not the material at my disposal to give an estimate of the cost of the measures which I have recommended, but I am sure that it will not be found to be prohibitive, and it has this great recommendation, that as malaria diminishes, though some of them must be permanent, others will become unnecessary, and expenditure will diminish. If we are to judge of the results elsewhere, a systematic campaign against malaria will in *three* years effect such a large reduction that there will be an enormous saving to the Government in hospital treatment alone.

## XII. EDUCATION IN SANITATION AND HYGIENE

Lastly, there is a matter to which it is necessary that attention should be drawn, and that is Sanitary Education. Adults should be attacked by means of pamphlets and circulars drawing attention to the evils of Malaria and the simple methods of its prevention, and the vast influence of the clergy can be utilised to no better purpose than by preaching at all seasons the gospel of cleanliness and sanitary surroundings. I make a strong appeal to them for their assistance.

Adults, however, are sometimes difficult to move, their ideas are more or less fixed, and their convictions too settled.

But *get hold of the children.*

I was much struck by seeing in the schools a series of practical 'Don'ts' dealing with every-day life, which was introduced by His Grace the Archbishop. Add to this some Sanitary 'Don'ts and Do's.' Hammer into their infantile heads the simple facts, 'Don't have wrigglers in your yard,' 'Do get rid of Mosquitoes,' until they become part and parcel of their intelligence, and they will never forget the lessons thus learned.

The children of this generation are the adults of the next, and if we can now instil into their minds, at its most receptive stage of growth, the great truths of Sanitary Science, we shall have, within a few years, thousands of intelligent adults, who will appreciate and be fully prepared to carry out, for their own sakes, the necessary measures to make Jamaica what, with its exquisite climate and enormous natural advantages, it ought to be, a Sanitary Paradise.

- 1. Mosquito, Reduction by
  - 1. Legislation against Larvae, — Immediate.
  - 2. Get rid of grass and weeds, in breeding places, — Immediate.
  - 3. Oil all breeding places, — Immediate.
  - 4. Cement gutters, — Gradual.
  - 5. Screen wells and tanks, — Gradual.
  - 6. Drain swamps. — Gradual.
- 2. Individual case reduction by
  - 1. Mosquito net,
  - 2. Mosquito proof dwellings, — Police. Public Hospitals. Coolies.
  - 3. Quinine administration. — Police. Coolies. Children. General population.
- Organisation
  - Central Board
  - Local Boards — Staff. Medical Officer. Mosquito gangs. Quinine Dispensers.
- Sanitary Education.

TABLE I. Showing areas in square miles at different elevations in each parish

| Parishes | Area below 1,000 feet | 1,000 to 2,000 feet | 2,000 to 3,000 feet | 3,000 to 4,000 feet | 4,000 to 5,000 feet | 5,000 feet and over | Total areas in square miles |
|---|---|---|---|---|---|---|---|
| Kingston | 6½ | 1⅔ | — | — | — | — | 7⅙ |
| St. Andrew | 59 | 54 | 27 | 17½ | 8 | ½ | 166 |
| St. Thomas | 135 | 59 | 35 | 20 | 14 | 11 | 274 |
| Portland | 94 | 89 | 40 | 32½ | 17 | 12½ | 285 |
| St. Mary | 110 | 116 | 19 | 4 | — | — | 249 |
| St. Ann | 85 | 337 | 54 | — | — | — | 476 |
| Trelawny | 166 | 135 | 32 | — | — | — | 333 |
| St. James | 139 | 90 | 5 | — | — | — | 234 |
| Hanover | 161 | 6 | — | — | — | — | 167 |
| Westmoreland | 235 | 73 | — | — | — | — | 308 |
| St. Elizabeth | 335 | 120 | 7 | — | — | — | 462 |
| Manchester | 42 | 134 | 126 | — | — | — | 302 |
| Clarendon | 314 | 115 | 45 | — | — | — | 474 |
| St. Catherine | 336 | 124 | 10 | — | — | — | 470 |
| Totals | 2,217½ | 1,452 | 400 | 74 | 39 | 24 | 4,207½ |

TABLE 2. The Island Monthly Rainfall from 1880 to 1905

| Year | Jan. | Feb. | Mar. | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | in. | in. | in. | in. | in. | in. | in. | in. | in. | in. | in. | in. | in. |
| 1880..... | 4·36 | 0·96 | 1·10 | 2·77 | 11·60 | 3·09 | 3·86 | 9·58 | 3·97 | 4·00 | 2·21 | 7·94 | 55·44 |
| 1881..... | 1·22 | 4·01 | 1·30 | 4·63 | 10·28 | 5·56 | 4·77 | 6·21 | 7·68 | 12·08 | 7·52 | 3·34 | 68·60 |
| 1882..... | 2·92 | 1·93 | 3·54 | 3·32 | 8·22 | 2·33 | 3·76 | 4·80 | 8·78 | 8·96 | 5·36 | 3·95 | 57·87 |
| 1883..... | 5·49 | 3·50 | 4·08 | 3·34 | 5·29 | 4·98 | 3·15 | 5·42 | 7·82 | 8·15 | 5·12 | 2·92 | 59·26 |
| 1884..... | 4·72 | 3·44 | 2·51 | 1·85 | 6·72 | 6·89 | 2·52 | 5·06 | 6·23 | 9·52 | 5·00 | 2·44 | 56·90 |
| 1885..... | 1·73 | 1·49 | 1·47 | 4·73 | 4·90 | 3·32 | 3·01 | 6·19 | 6·22 | 6·37 | 4·74 | 15·69 | 59·86 |
| 1886..... | 5·23 | 4·65 | 2·68 | 6·39 | 5·30 | 23·36 | 6·22 | 13·54 | 5·90 | 7·98 | 3·70 | 5·66 | 90·61 |
| 1887..... | 6·02 | 2·32 | 2·38 | 4·47 | 9·32 | 8·89 | 7· 9 | 6·91 | 5·77 | 8·47 | 8·17 | 0·75 | 70·66 |
| 1888..... | 1·36 | 1·89 | 1·70 | 3·61 | 21·24 | 6·77 | 2·65 | 5·47 | 8·10 | 4·38 | 4·59 | 10·35 | 72·11 |
| 1889..... | 4·78 | 0·90 | 4·19 | 6·71 | 7·82 | 12·52 | 6·08 | 5·12 | 8·20 | 10·49 | 4·37 | 2·97 | 74·15 |
| Means ..... | 3·78 | 2·51 | 2·49 | 4·18 | 9·07 | 7·77 | 4·32 | 6·83 | 6·87 | 8·04 | 5·08 | 5·60 | 66·54 |
| 1890..... | 5·21 | 2·92 | 5·84 | 3·37 | 5·57 | 4·13 | 4·99 | 6·92 | 6·52 | 7·04 | 6·52 | 5·39 | 64·42 |
| 1891..... | 3·45 | 2·24 | 0·84 | 8·49 | 12·28 | 9·91 | 5·57 | 7·45 | 6·35 | 15·32 | 7·65 | 5·15 | 84·70 |
| 1892..... | 4·00 | 1·38 | 2·27 | 2·82 | 8·53 | 7·31 | 4·44 | 7·65 | 8·86 | 12·17 | 9·96 | 3·61 | 73·00 |
| 1893..... | 3·44 | 3·24 | 1·92 | 5·42 | 10·90 | 7·20 | 9·15 | 6·72 | 7·92 | 10·30 | 10·10 | 10·18 | 86·49 |
| 1894..... | 2·05 | 2·52 | 3·33 | 5·84 | 16·64 | 3·90 | 5·92 | 4·20 | 6·98 | 12·40 | 5·05 | 6·56 | 75·39 |
| 1895..... | 1·31 | 5·00 | 2·18 | 6·11 | 9·90 | 3·66 | 4·99 | 8·11 | 6·87 | 11·98 | 7·72 | 3·79 | 71·62 |
| 1896..... | 5·25 | 4·86 | 4·28 | 3·67 | 9·96 | 4·84 | 5·03 | 4·74 | 8·24 | 7·51 | 4·57 | 5·66 | 68·61 |
| 1897..... | 0·88 | 0·77 | 1·82 | 7·06 | 10·91 | 4·92 | 5·92 | 6·55 | 10·13 | 19·26 | 5·73 | 3·64 | 77·59 |
| 1898..... | 1·75 | 3·93 | 1·26 | 4·09 | 16·76 | 7·60 | 6·50 | 6·92 | 7·10 | 10·38 | 4·78 | 2·75 | 73·82 |
| 1899..... | 3·96 | 2·84 | 3·76 | 4·80 | 4·20 | 4·66 | 3·86 | 4·22 | 7·44 | 23·72 | 14·99 | 7·37 | 85·82 |
| Means ..... | 3·13 | 2·97 | 2·75 | 5·17 | 10·56 | 5·81 | 5·64 | 6·35 | 7·64 | 13·01 | 7·71 | 5·41 | 76·15 |
| 1900..... | 5·20 | 4·15 | 2·42 | 5·67 | 7·77 | 6·16 | 7·18 | 5·38 | 8·12 | 6·50 | 5·22 | 5·88 | 69·65 |
| 1901..... | 3·91 | 1·17 | 3·32 | 2·57 | 6·13 | 14·03 | 7·59 | 6·49 | 10·60 | 9·76 | 10·02 | 5·37 | 80·96 |
| 1902 ..... | 5·68 | 3·06 | 4·24 | 5·40 | 8·97 | 10·28 | 3·44 | 5·39 | 5·89 | 7·19 | 5·60 | 8·23 | 73·37 |
| 1903..... | 1·94 | 1·40 | 3·19 | 4·90 | 10·63 | 6·00 | 4·30 | 12·79 | 5·34 | 7·28 | 5·78 | 4·83 | 68·38 |
| 1904..... | 3·42 | 4·66 | 6·84 | 5·91 | 7·51 | 15·20 | 4·26 | 5·47 | 6·49 | 16·58 | 7·87 | 3·94 | 88·15 |
| 1905..... | 7·83 | 2·99 | 7·48 | 5·14 | 8·20 | 10·10 | 2·73 | 6· 7 | 8·27 | 12·36 | 6·77 | 7·17 | 85·20 |
| 1906..... | 3·37 | 5·15 | 5·50 | 8·02 | 13·23 | 11·47 | 4·19 | 6·98 | 10·70 | 8·44 | 7·60 | 2·06 | 86·71 |

TABLE 3. Annual Rainfall for each Rainfall Division in Jamaica

| Year | Rainfall Divisions | | | | The Island |
|---|---|---|---|---|---|
| | N.E. Division | N. Division | W.C. Division | S. Division | |
| | in. | in. | in. | in. | in. |
| 1870..... | 110·60 | 83·09 | 102·98 | 61·07 | 89·43 |
| 1871..... | 69·45 | 41·88 | 54·56 | 34·46 | 50·09 |
| 1872..... | 59·42 | 40·79 | 51·50 | 29·02 | 45·18 |
| 1873..... | 84·08 | 52·64 | 67·79 | 47·71 | 63·06 |
| 1874..... | 97·18 | 68·25 | 62·97 | 47·35 | 68·94 |
| 1875..... | 71·89 | 47·15 | 56·16 | 34·47 | 52·42 |
| 1876..... | 90·38 | 54·71 | 87·33 | 52·99 | 71·35 |
| 1877..... | 100·72 | 56·53 | 64·06 | 52·27 | 68·40 |
| 1878..... | 104·12 | 62·99 | 72·44 | 66·11 | 76·42 |
| 1879..... | 122·55 | 65·44 | 87·54 | 79·85 | 88·84 |
| Means ..... | 91·04 | 57·34 | 70·73 | 50·53 | 67·41 |
| 1880..... | 76·37 | 47·01 | 64·91 | 33·47 | 55·44 |
| 1881..... | 91·24 | 49·42 | 75·32 | 58·42 | 68·60 |
| 1882..... | 65·48 | 43·76 | 78·59 | 43·67 | 57·87 |
| 1883..... | 72·30 | 41·52 | 78·19 | 45·02 | 59·26 |
| 1884..... | 69·00 | 41·87 | 73·10 | 43·63 | 56·90 |
| 1885..... | 70·55 | 52·77 | 72·62 | 43·52 | 59·86 |
| 1886..... | 126·61 | 60·98 | 88·21 | 86·64 | 90·61 |
| 1887..... | 80·25 | 61·07 | 80·14 | 61·16 | 70·66 |
| 1888..... | 98·00 | 54·42 | 70·43 | 65·58 | 72·11 |
| 1889..... | 99·81 | 56·82 | 75·94 | 64·02 | 74·15 |
| Means ..... | 84·96 | 50·96 | 75·74 | 54·51 | 66·54 |
| 1890..... | 75·09 | 48·29 | 89·91 | 44·41 | 64·42 |
| 1891..... | 110·56 | 66·71 | 100·50 | 61·03 | 84·70 |
| 1892..... | 101·55 | 58·10 | 82·05 | 50·29 | 73·00 |
| 1893..... | 106·50 | 63·17 | 108·66 | 67·65 | 86·49 |
| 1894..... | 90·56 | 54·04 | 95·93 | 61·01 | 75·39 |
| 1895..... | 97·38 | 56·35 | 85·38 | 47·36 | 71·62 |
| 1896..... | 95·42 | 54·90 | 78·31 | 45·79 | 68·61 |
| 1897..... | 93·95 | 58·25 | 95·46 | 62·67 | 77·59 |
| 1898..... | 102·92 | 52·44 | 84·26 | 55·67 | 73·82 |
| 1899..... | 112·10 | 61·31 | 101·28 | 68·62 | 85·82 |
| Means ..... | 98·60 | 57·36 | 92·17 | 56·45 | 76·15 |
| 1900..... | 96·91 | 50·67 | 79·84 | 51·15 | 69·65 |
| 1901..... | 107·88 | 64·18 | 87·31 | 64·50 | 80·96 |
| 1902..... | 95·97 | 58·78 | 89·75 | 49·14 | 73·37 |
| 1903..... | 88·46 | 51·05 | 82·83 | 51·17 | 68·38 |
| 1904..... | 112·12 | 63·72 | 104·40 | 72·35 | 88·15 |
| 1905..... | 112·91 | 61·33 | 94·23 | 72·31 | 85·20 |
| 1906..... | 109·69 | 56·25 | 100·90 | 79·96 | 86·71 |

TABLE 4. Average Annual Temperatures at different elevations in Jamaica

| Elevation above sea-level | Mean | Max. | Min. | Range |
|---|---|---|---|---|
| Feet | | | | |
| 0 | 78·8 | 87·5 | 70·8 | 16·7 |
| 500 | 77·1 | 85·1 | 69·8 | 15·3 |
| 1,000 | 75·3 | 82·8 | 68·6 | 14·2 |
| 1,500 | 73·6 | 80·6 | 67·4 | 13·2 |
| 2,000 | 72·0 | 78·6 | 66·1 | 12·5 |
| 2,500 | 70·3 | 76·7 | 64·7 | 12·0 |
| 3,000 | 68·7 | 74·9 | 63·3 | 11·6 |
| 3,500 | 67·1 | 73·2 | 61·7 | 11·5 |
| 4,000 | 65·5 | 71·6 | 60·1 | 11·5 |
| 4,500 | 64·0 | 70·1 | 58·5 | 11·6 |
| 5,000 | 62·4 | 68·8 | 56·8 | 12·0 |
| 5,500 | 61·0 | 67·5 | 55·0 | 12·5 |
| 6,000 | 59·5 | 66·3 | 53·1 | 13·2 |
| 6,500 | 58·0 | 65·2 | 51·2 | 14·0 |
| 7,000 | 56·5 | 64·3 | 49·3 | 15·0 |
| 7,500 | 55·1 | 63·6 | 47·3 | 16·3 |

TABLE 5. Showing Estimated Population of Parishes, Total and Malarial Death-rates, etc.

| | KINGSTON (including Port Royal) | | | | | | ST. ANDREW | | | | | | ST. THOMAS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Estimated Pop. | Total deaths from all causes | Total death-rate | Total deaths from mal. | Death-rate mal. | Percentage of mal. deaths to total deaths | Estimated Pop. | Total deaths from all causes | Total death-rate | Total deaths from mal. | Death-rate mal. | Percentage of mal. deaths to total deaths | Estimated Pop. | Total deaths from all causes | Total death-rate | Total deaths from mal. | Death-rate mal. | Percentage of mal. deaths to total deaths |
| 1898 ... | 51,330 | 1,491 | 29·0 | 136 | 2·6 | 9·1 | 41,052 | 1,126 | 27·4 | 172 | 4·1 | 15·2 | 35,775 | 944 | 26·3 | 224 | 6·2 | 23·7 |
| 1899 ... | 51,693 | 1,414 | 27·3 | 104 | 2·01 | 7·3 | 41,447 | 1,058 | 25·5 | 138 | 3·3 | 13·0 | 36,338 | 854 | 23·5 | 233 | 6·6 | 27·2 |
| 1900 ... | 52,274 | 1,453 | 27·7 | 128 | 2·4 | 8·8 | 41,838 | 1,164 | 27·8 | 210 | 5·0 | 18·0 | 36,928 | 1,007 | 27·5 | 297 | 8·0 | 29·4 |
| 1901 ... | 52,475 | 1,421 | 27·0 | 115 | 2·1 | 8·0 | 42,161 | 1,074 | 25·4 | 156 | 3·7 | 14·5 | 37,299 | 901 | 24·1 | 250 | 6·7 | 27·7 |
| 1902 ... | 53,174 | 1,455 | 27·3 | 183 | 3·4 | 12·5 | 42,665 | 1,096 | 25·6 | 210 | 4·9 | 19·1 | 38,044 | 905 | 23·7 | 257 | 6·7 | 28·3 |
| 1903 ... | 53,750 | 1,365 | 25·3 | 96 | 1·7 | 7·0 | 43,386 | 880 | 20·2 | 130 | 2·9 | 14·7 | 38,692 | 785 | 20·2 | 212 | 5·4 | 27·0 |
| 1904 ... | 54,258 | 1,607 | 29·6 | 109 | 2·0 | 6·7 | 43,739 | 1,343 | 30·7 | 198 | 4·5 | 14·7 | 39,046 | 1,146 | 29·3 | 325 | 8·3 | 28·3 |
| 1905 ... | 54,668 | 1,611 | 29·5 | 127 | 2·3 | 7·8 | 43,926 | 1,351 | 30·7 | 162 | 3·6 | 11·9 | 39,397 | 955 | 24·2 | 197 | 5·0 | 20·6 |
| 1906 ... | 55,068 | 1,544 | 28·0 | 177 | 3·2 | 11·4 | 44,256 | 1,287 | 29·0 | 191 | 4·3 | 14·8 | 40,028 | 995 | 24·8 | 237 | 5·9 | 23·8 |
| 1907 ... | 54,880 | 2,040 | 37·1 | 161 | 2·9 | 7·8 | 44,256 | 1,660 | 37·5 | 183 | 4·1 | 11·0 | 40,298 | 1,077 | 26·7 | 280 | 6·9 | 25·9 |
| Mean | — | — | 28·7 | — | 2·4 | 8·6 | — | — | 27·9 | — | 4·0 | 14·6 | — | — | 25·0 | — | 6·5 | 26·1 |
| | PORTLAND | | | | | | ST. MARY | | | | | | ST. ANN | | | | | |
| 1898 ... | 35,858 | 856 | 23·8 | 136 | 3·7 | 15·8 | 48,653 | 990 | 20·3 | 183 | 3·7 | 18·4 | 62,728 | 1,161 | 18·5 | 235 | 3·7 | 20·2 |
| 1899 ... | 36,546 | 798 | 21·8 | 149 | 4·0 | 18·6 | 49,601 | 1,030 | 20·7 | 209 | 4·0 | 20·2 | 64,296 | 1,024 | 15·9 | 166 | 2·5 | 16·2 |
| 1900 ... | 37,231 | 945 | 25·3 | 245 | 6·5 | 25·9 | 50,816 | 1,054 | 20·7 | 285 | 5·6 | 27·0 | 65,849 | 1,328 | 20·1 | 279 | 4·2 | 21·0 |
| 1901 ... | 37,817 | 910 | 24·0 | 215 | 5·6 | 23·6 | 51,671 | 1,185 | 22·9 | 298 | 5·7 | 25·1 | 67,133 | 1,225 | 18·2 | 276 | 4·1 | 22·4 |
| 1902 ... | 38,727 | 852 | 22·0 | 184 | 4·7 | 21·5 | 52,861 | 1,203 | 22·7 | 281 | 5·3 | 23·3 | 68,775 | 1,139 | 16·5 | 196 | 2·8 | 17·2 |
| 1903 ... | 39,586 | 903 | 22·6 | 193 | 4·8 | 21·3 | 54,093 | 1,228 | 22·7 | 319 | 5·8 | 23·5 | 70,415 | 1,210 | 17·0 | 289 | 4·1 | 23·8 |
| 1904 ... | 39,991 | 1,284 | 32·1 | 299 | 7·4 | 23·2 | 54,621 | 1,732 | 31·7 | 480 | 8·7 | 27·7 | 71,642 | 1,528 | 21·3 | 297 | 4·1 | 19·4 |
| 1905 ... | 40,431 | 1,040 | 25·7 | 239 | 5·9 | 22·9 | 55,201 | 1,490 | 26·9 | 419 | 7·5 | 28·1 | 72,879 | 1,342 | 18·4 | 227 | 3·1 | 16·9 |
| 1906 ... | 41,433 | 942 | 22·7 | 244 | 5·8 | 25·9 | 56,450 | 1,415 | 25·0 | 404 | 7·1 | 28·5 | 74,655 | 1,140 | 15·2 | 207 | 2·7 | 18·1 |
| 1907 ... | 41,979 | 1,099 | 26·1 | 225 | 5·3 | 20·4 | 57,462 | 1,457 | 25·3 | 365 | 6·3 | 24·9 | 76,240 | 1,411 | 18·5 | 271 | 3·5 | 19·2 |
| Mean | — | — | 24·6 | — | 5·3 | 21·9 | — | — | 23·8 | — | 5·9 | 24·6 | — | — | 17·9 | — | 3·4 | 19·4 |

TABLE 5—*continued.*

| | Trelawny | | | | | | St. James | | | | | | Hanover | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Estimated Pop. | Total deaths from all causes | Total death-rate | Total deaths from mal. | Death-rate mal. | Percentage of mal. deaths to total deaths | Estimated Pop. | Total deaths from all causes | Total death-rate | Total deaths from mal. | Death-rate mal. | Percentage of mal. deaths to total deaths | Estimated Pop. | Total deaths from all causes | Total death-rate | Total deaths from mal. | Death-rate mal. | Percentage of mal. deaths to total deaths |
| 1898 ... | 33,786 | 853 | 25·2 | 149 | 4·4 | 17·4 | 37,661 | 821 | 21·7 | 209 | 5·5 | 25·4 | 35,617 | 836 | 23·4 | 192 | 5·3 | 22·9 |
| 1899 ... | 34,249 | 819 | 23·9 | 133 | 3·8 | 16·2 | 38,137 | 793 | 20·7 | 188 | 4·9 | 23·7 | 36,162 | 820 | 22·6 | 172 | 4·7 | 20·9 |
| 1900 ... | 34,793 | 917 | 26·3 | 118 | 3·3 | 12·8 | 38,599 | 905 | 23·4 | 183 | 4·7 | 20·2 | 36,877 | 811 | 21·9 | 132 | 3·5 | 16·2 |
| 1901 ... | 35,095 | 880 | 25·0 | 129 | 3·6 | 14·6 | 38,967 | 827 | 21·2 | 168 | 4·3 | 20·3 | 37,373 | 924 | 24·7 | 204 | 5·4 | 22·0 |
| 1902 ... | 35,653 | 885 | 24·8 | 153 | 4·2 | 17·2 | 39,525 | 809 | 20·4 | 213 | 5·3 | 26·3 | 38,037 | 915 | 24·0 | 230 | 6·0 | 25·1 |
| 1903 ... | 36,206 | 778 | 21·4 | 116 | 3·2 | 14·9 | 39,992 | 795 | 19·8 | 173 | 4·3 | 21·7 | 38,603 | 872 | 22·5 | 203 | 5·2 | 20·6 |
| 1904 ... | 36,672 | 979 | 26·6 | 117 | 3·2 | 11·9 | 40,400 | 928 | 22·9 | 202 | 5·0 | 21·7 | 39,215 | 971 | 24·7 | 180 | 4·5 | 18·5 |
| 1905 ... | 37,081 | 930 | 25·0 | 99 | 2·6 | 10·6 | 40,724 | 927 | 22·7 | 183 | 4·4 | 19·7 | 39·547 | 1,081 | 27·3 | 179 | 4·5 | 16·4 |
| 1906 ... | 37,720 | 806 | 21·1 | 113 | 2·9 | 14·0 | 41,457 | 844 | 20·3 | 199 | 4·8 | 23·5 | 40,055 | 985 | 24·5 | 190 | 4·7 | 19·2 |
| 1907 ... | 38,265 | 908 | 23·2 | 131 | 3·3 | 14·4 | 41,880 | 1,085 | 25·9 | 226 | 5·3 | 20·8 | 40,515 | 1,140 | 28·1 | 205 | 5·0 | 17·9 |
| Mean | — | — | 24·2 | — | 3·4 | 14·4 | — | — | 21·9 | — | 4·8 | 22·3 | — | — | 24·3 | — | 4·8 | 19·9 |

| | Westmoreland | | | | | | St. Elizabeth | | | | | | Manchester | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1898 ... | 59,745 | 1,347 | 22·5 | 416 | 6·9 | 30·8 | 72,464 | 1,484 | 20·4 | 285 | 3·9 | 19·2 | 65,587 | 1,137 | 17·3 | 112 | 1·7 | 9·8 |
| 1899 ... | 60,690 | 1,283 | 21·1 | 334 | 5·5 | 26·0 | 74,028 | 1,284 | 17·3 | 195 | 2·6 | 15·1 | 67,124 | 1,005 | 14·9 | 77 | 1·1 | 7·6 |
| 1900 ... | 61,974 | 1,346 | 21·7 | 365 | 5·8 | 27·1 | 76,020 | 1,510 | 19·8 | 225 | 2·9 | 14·8 | 68,872 | 1,075 | 15·6 | 101 | 1·4 | 9·4 |
| 1901 ... | 62,905 | 1,236 | 19·6 | 324 | 5·1 | 26·2 | 77·553 | 1,326 | 17·0 | 209 | 2·6 | 15·7 | 70,294 | 1,085 | 15·4 | 112 | 1·5 | 10·3 |
| 1902 ... | 64,010 | 1,481 | 23·1 | 441 | 6·8 | 29·7 | 79,223 | 1,497 | 18·8 | 302 | 3·8 | 20·1 | 71,923 | 1,125 | 15·6 | 163 | 2·2 | 14·4 |
| 1903 ... | 65,195 | 1,211 | 18·5 | 388 | 5·9 | 32·0 | 81,233 | 1,259 | 15·4 | 225 | 2·7 | 17·8 | 73,783 | 1,055 | 14·2 | 103 | 1·3 | 9·7 |
| 1904 ... | 66,489 | 1.394 | 20·9 | 371 | 5·5 | 26·6 | 83,120 | 1,524 | 18·3 | 209 | 2·5 | 13·7 | 75,560 | 1,128 | 14·9 | 116 | 1·5 | 10·2 |
| 1905 ... | 67,294 | 1,703 | 25·1 | 388 | 5·7 | 22·7 | 84,546 | 1,718 | 20·3 | 218 | 2·5 | 12·6 | 76,922 | 1,481 | 19·2 | 105 | 1·3 | 7·0 |
| 1906 ... | 68,313 | 1,437 | 21·0 | 434 | 6·3 | 30·2 | 86,239 | 1,573 | 18·2 | 223 | 2·5 | 14·1 | 78,237 | 1,254 | 16·0 | 121 | 1·5 | 9·6 |
| 1907 ... | 69,281 | 1,685 | 24·3 | 439 | 6·3 | 26·0 | 87,691 | 1,785 | 20·3 | 270 | 3·0 | 15·1 | 79,362 | 1,687 | 21·2 | 207 | 2·6 | 12·2 |
| Mean | — | — | 21·7 | — | 5·9 | 27·7 | — | — | 18·5 | — | 2·9 | 15·8 | — | — | 16·4 | — | 1·6 | 10·0 |

TABLE 5—*continued.*

| | Clarendon | | | | | | St. Catherine | | | | | | Whole Island | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Estimated Pop. | Total deaths from all causes | Total death-rate | Total deaths from mal. | Death-rate mal. | Percentage of mal. deaths to total deaths | Estimated Pop. | Total deaths from all causes | Total death-rate | Total deaths from mal. | Death-rate mal. | Percentage of mal. deaths to total deaths | Estimated Pop. | Total deaths from all causes | Total death-rate | Total deaths from mal. | Death-rate mal. | Percentage of mal. deaths to total deaths |
| 1898 ... | 65,121 | 1,538 | 23·6 | 398 | 6·1 | 25·9 | 73,060 | 1,890 | 25·8 | 433 | 5·9 | 22·9 | 718,347 | 16,474 | 22·9 | 3,285 | 4·5 | 19·9 |
| 1899 ... | 66,306 | 1,452 | 21·8 | 339 | 5·1 | 24·0 | 74,158 | 1,656 | 22·3 | 352 | 4·7 | 21·2 | 730,725 | 15,290 | 20·9 | 2,789 | 3·8 | 18·2 |
| 1900 ... | 67,577 | 1,509 | 22·3 | 356 | 5·2 | 23·5 | 75,456 | 1,856 | 24·5 | 472 | 6·2 | 25·4 | 745,104 | 16,880 | 22·6 | 3,396 | 4·5 | 20·1 |
| 1901 ... | 68,692 | 1,418 | 20·6 | 361 | 5·2 | 25·4 | 76,295 | 1,911 | 25·4 | 500 | 6·5 | 26·1 | 755,730 | 16,243 | 21·4 | 3,317 | 4·3 | 20·4 |
| 1902 ... | 70,088 | 1,459 | 20·8 | 434 | 6·1 | 29·7 | 77,537 | 1,935 | 24·9 | 535 | 6·8 | 27·6 | 770,242 | 16,756 | 21·7 | 3,782 | 4·9 | 22·5 |
| 1903 ... | 71,548 | 1,360 | 18·9 | 345 | 4·8 | 25·3 | 78,952 | 1,712 | 21·6 | 385 | 4·8 | 22·4 | 785,434 | 15,413 | 19·6 | 3,177 | 4·0 | 20·6 |
| 1904 ... | 72,819 | 1,677 | 23·0 | 379 | 5·2 | 22·5 | 79,974 | 2,352 | 29·4 | 540 | 6·7 | 22·9 | 797,528 | 19,593 | 24·5 | 3,822 | 4·9 | 19·5 |
| 1905 ... | 73,566 | 1,921 | 26·1 | 322 | 4·3 | 16·7 | 80,508 | 2,313 | 28·7 | 544 | 6·7 | 23·5 | 806,690 | 19,863 | 24·6 | 3,409 | 4·2 | 17·1 |
| 1906 ... | 74,792 | 1,624 | 21·7 | 354 | 4·7 | 24·1 | 81,734 | 2,025 | 24·7 | 530 | 6·4 | 26·1 | 820,437 | 17,871 | 21·7 | 3,624 | 4·4 | 20·2 |
| 1907 ... | 75,424 | 2.295 | 30·4 | 498 | 6·6 | 21·6 | 82,728 | 2,394 | 28·9 | 633 | 7·6 | 26·4 | 830,261 | 21,723 | 26·1 | 4,094 | 4·9 | 18·8 |
| Mean | — | — | 20·5 | — | 5·3 | 23·8 | — | — | 25·6 | — | 6·2 | 24·4 | — | — | 22·6 | 34,695 | 4·4 | 19·7 |

TABLE 6. Return showing the admissions from Malaria into the various Hospitals of the Island, from 1898 to 1908.

| District | Hospital | 1898 | 1899 | 1900 | 1901 | 1902 | 1903 | 1904 | 1905 | 1906 | 1907 | 1908 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| St. Thomas | Morant Bay | 123 | 56 | 83 | 102 | 103 | 187 | 109 | 161 | 131 | 118 | — |
| | Hordley | No | return | | | | | 175 | 241 | 377 | 201 | — |
| Portland | Port Antonio | — | 997 | 764 | 670 | 399 | 649 | 528 | 645 | 604 | 1,352 | 1,694 |
| " | Buff Bay | — | 280 | 234 | 173 | 184 | 425 | 357 | 225 | 157 | 419 | 396 |
| St. Mary | Annotto Bay* | No | detailed | return | | | | | | | | |
| " | Port Maria | 120 | 160 | 248 | 204 | 242 | 435 | 514 | 532 | 302 | 326 | — |
| St. Ann | St. Ann's Bay | 40 | 21 | 54 | 28 | 31 | 31 | 32 | 36 | 39 | 43 | — |
| " | Cave Valley | 4 | 3 | 2 | 3 | 2 | 3 | 3 | 5 | 1 | 2 | — |
| Trelawny | Falmouth | 47 | 21 | 87 | 83 | 29 | 26 | 100 | 71 | 20 | 25 | — |
| St. James | Montego Bay | 66 | 31 | 55 | 69 | 41 | 31 | 29 | 33 | 26 | 27 | — |
| Hanover | Lucca | — | 10 | 13 | 14 | 23 | 66 | 23 | 33 | 33 | 10 | 27 |
| Westmoreland | Savanna-la-Mar | — | 186 | 173 | 119 | 31 | 28 | 34 | 32 | 345 | 359 | 420 |
| St. Elizabeth | Black River | 52 | 45 | 44 | 37 | 21 | 27 | 35 | 37 | 38 | 53 | 36 |
| Manchester | Mandeville | No | return | | | | | | | | | |
| Clarendon | Chapelton | — | 22 | 21 | 15 | 18 | 30 | 15 | 43 | 93 | 79 | 64 |
| " | Lionel Town | No | return | | | | | | | | | |
| | Spanish Town | — | 289 | 474 | 411 | 272 | 368 | 382 | 553 | 638 | 464 | 525 |
| | Kingston | — | 525 | 733 | 1,205 | 557 | 571 | 625 | 840 | 1,066 | 702 | 122 |
| | Totals | — | 2,646 | 2,985 | 3,133 | 1,953 | 2,877 | 2,961 | 3,487 | 4,940 | 4,180 | – |

* 12,470 cases of malaria recorded from March 1, 1898, to 30 November, 1908

TABLE 7. Showing number of admissions from malaria in all the public hospitals. Jamaica, 1907-08.

| | April | May | June | July | August | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | March | Total | Deaths | Pernicious Malaria | Deaths |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Morant Bay ..... | 6 | 4 | 1 | 9 | 11 | 15 | 8 | 13 | 24 | 25 | 17 | 19 | 152 | 3 | 2 | 2 |
| Hordley..... | 7 | 10 | 10 | 18 | 22 | 23 | 25 | 9 | 38 | 17 | 22 | 19 | 220 | 2 | — | — |
| Port Antonio ..... | 32 | 26 | 35 | 106 | 218 | 249 | 243 | 163 | 206 | 202 | 86 | 45 | 1,611 | 7 | — | — |
| Buff Bay ..... | 7 | 7 | 16 | 42 | 60 | 83 | 45 | 61 | 64 | 61 | 32 | 29 | 507 | 8 | 2 | 2 |
| Annotto Bay ..... | 92 | 60 | 66 | 93 | 55 | 85 | 108 | 186 | 342 | 343 | 218 | 132 | 1,780 | 18 | — | — |
| Port Maria ..... | 24 | 7 | 13 | 21 | 22 | 32 | 32 | 45 | 85 | 73 | 47 | 43 | 444 | 4 | 3 | 2 |
| St. Ann's Bay ..... | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 5 | 10 | 6 | 7 | 3 | 49 | — | — | — |
| Cave Valley ..... | — | — | — | — | — | — | — | — | — | 1 | 1 | — | 2 | — | 1 | — |
| Falmouth ..... | — | 3 | — | 2 | 2 | 6 | 2 | 6 | 1 | — | — | 1 | 23 | 5 | 2 | 1 |
| Montego Bay ..... | 4 | — | 2 | — | 3 | 3 | 9 | 3 | 4 | 4 | 2 | 2 | 36 | — | — | — |
| Lucea ..... | 5 | 4 | 2 | 2 | 6 | 3 | 2 | 2 | 2 | 3 | — | — | 31 | 3 | — | — |
| Sav.-la-Mar ..... | 19 | 13 | 18 | 40 | 33 | 27 | 47 | 42 | 37 | 38 | 41 | 33 | 388 | — | — | — |
| Black River ..... | 1 | — | 2 | 3 | 6 | 4 | 14 | 9 | 10 | 5 | 5 | 1 | 60 | — | — | — |
| Mandeville ..... | — | — | 1 | — | — | — | — | 1 | 2 | — | 1 | — | 5 | — | — | — |
| Chapelton ..... | 6 | 3 | 7 | 3 | 7 | 7 | 7 | 3 | 15 | 19 | 7 | 5 | 89 | 1 | — | — |
| Lionel Town ..... | 138 | 89 | 50 | 81 | 59 | 31 | 60 | 47 | 84 | 122 | 85 | 87 | 913 | 3 | — | — |
| Spanish Town ..... | 24 | 19 | 31 | 54 | 41 | 58 | 38 | 49 | 72 | 55 | 45 | 28 | 514 | 35 | 21 | 13 |
| Totals ..... | 367 | 248 | 256 | 477 | 548 | 628 | 643 | 644 | 996 | 974 | 616 | 447 | 6,844 | 89 | 31 | 20 |
| Kingston P.H. ..... | 45 | 55 | 48 | 71 | 87 | 64 | 66 | 67 | 53 | 52 | 33 | 25 | 666 | 32 | — | 1 |
| Grand totals ..... | 412 | 303 | 304 | 548 | 635 | 692 | 709 | 711 | 1,049 | 1,026 | 649 | 472 | 7,510 | 121 | 31 | 21 |

TABLE 8. Table showing the amount of working days lost through illness on various estates.

| Estate | District | 1907 | | | | 1908 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total No. of working days in period | Average daily No. of men employed | Total No. of working days spent in hospital | Percentage of working days lost through sickness | Total No. of working days in period | Average daily No. of men employed | Total No. of working days spent in hospital | Percentage of working days lost through sickness |
| A | St. Thomas ... | 10,920 | 35 | 266 | 2·4 | 11,130 | 35 | 1,499 | 13·5 |
| B | Portland ..... | 6,552 | 21 | 693 | 10·5 | 6,678 | 21 | 504 | 7·5 |
| C | ,, ... | 13,416 | 43 | 2,760 | 20·5 | 24,960 | 80 | 10,431 | 41·7 |
| D | St. Mary ..... | 9,672 | 31 | 1,101 | 11·3 | 12,084 | 38 | 1,686 | 13·3 |
| E | ,, ..... | 13,728 | 44 | 1,870 | 14·4 | 12,042 | 39 | 2,544 | 20·5 |
| F | ,, ..... | 4,368 | 14 | 834 | 19·0 | 2,862 | 9 | 411 | 14·3 |
| G | ,. ..... | 4,056 | 13 | 516 | 12·9 | 5,088 | 16 | 768 | 11·1 |
| H | Westmoreland | 6,240 | 20 | 1,498 | 24·0 | 7,950 | 25 | 2,170 | 27·2 |
| I | ,, | 6,240 | 20 | 848 | 13·5 | 6,042 | 19 | 958 | 15·8 |
| K | Clarendon ... | 26,208 | 70 | 4,999 | 19·0 | 18,126 | 57 | 1,544 | 8·4 |
| L | ,, ..... | 24,648 | 79 | 4,103 | 16·6 | 24,464 | 77 | 3,014 | 12·3 |
| M | ,, ..... | 13,728 | 44 | 2,233 | 16·2 | 13,356 | 42 | 1,031 | 7·7 |
| | | 139,776 | — | 21,721 | 15·5 | 144,782 | — | 26,560 | 18·3 |

Percentage of days lost through sickness during two years, 16·9.

TABLE 9. Showing number of cases of malaria among the Jamaica constabulary

| Parish and constabulary station | 1907 | | | 1908 | | |
|---|---|---|---|---|---|---|
| | No. of cases of malaria at station | No. of S.O's and men at station | Percentage of cases of malaria | No. of cases of malaria at station | No. of S.O's and men at station | Percentage of cases of malaria |
| KINGSTON | | | | | | |
| Sutton Street | 31 | 170 | 18·2 | 36 | 170 | 21·1 |
| Port Royal | — | 6 | — | — | 6 | — |
| Rock Fort | — | 3 | — | — | 3 | — |
| Rae Town | — | 4 | — | — | 4 | — |
| Brown's Town | — | 4 | — | — | 4 | — |
| Franklin Town | — | 4 | — | — | 4 | — |
| South Camp Road | — | 4 | — | — | 4 | — |
| Allman Town | — | 4 | — | — | 4 | — |
| Fletcher's Town | — | 4 | — | — | 4 | — |
| Hannah's Town | — | 4 | — | — | 4 | — |
| Smith's Village | — | 4 | — | — | 5 | — |
| Water Police | 1 | 15 | — | 1 | 15 | — |
| ST. ANDREW | | | | | | |
| Half Way Tree | 19 | 32 | 59·3 | 16 | 41 | 39·0 |
| Cross Roads | 11 | 24 | 45·8 | 9 | 28 | 32·1 |
| Mathilda's Corner | 2 | 11 | 17·2 | — | 13 | — |
| Gordon Town | 3 | 7 | 42·8 | 1 | 7 | 14·2 |
| Guava Ridge | — | 5 | — | 1 | 5 | — |
| Stoney Hill | 2 | 9 | — | — | 9 | — |
| Laurence Tavern | 1 | 10 | 10·0 | 3 | 10 | 30·0 |
| Bull Bay* | 11 | 14 | | — | 3 | — |
| ST. THOMAS | | | | | | |
| Morant Bay | 22 | 14 | 157·1 | 31 | 13 | 238·4 |
| Bath | 2 | 3 | — | 2 | 3 | — |
| Golden Grove | 3 | 3 | — | 3 | 3 | — |
| Port Morant | 3 | 2 | — | 5 | 2 | — |
| Yallas | 3 | 3 | — | 3 | 3 | — |
| Llandewey | 1 | 2 | — | 1 | 2 | — |
| Trinity Ville | 1 | 3 | — | 0 | 3 | — |
| Cedar Valley | — | 3 | — | — | 3 | — |
| Hagley Gap | 1 | 2 | — | 1 | 2 | — |
| PORTLAND | | | | | | |
| Port Antonio | 49 | 25 | 196·0 | 37 | 28 | 132·1 |
| Manchioneal | 5 | 4 | — | — | 4 | — |
| Castle | 4 | 3 | — | 2 | 3 | — |
| Buff Bay | 10 | 4 | 250·0 | 6 | 5 | 120·0 |
| Hope Bay | 4 | 4 | — | 2 | 4 | — |
| St. Margaret's Bay | 3 | 3 | — | 2 | 2 | — |
| ST. MARY | | | | | | |
| Port Maria | 46 | 20 | 230·0 | 56 | 20 | 280·0 |
| Annotto Bay | 61 | 10 | 610·0 | 68 | 10 | 680·0 |
| Castleton | 1 | 3 | — | — | 2 | — |
| Richmond | 5 | 5 | — | 7 | 6 | — |
| Lucky Hill | 2 | 3 | — | 1 | 3 | — |
| Retreat | — | 3 | — | 2 | 3 | — |
| Oracabessa | 3 | 3 | — | 3 | 3 | — |

* Section closed 1 February, 1908

TABLE 9. Showing number of cases of malaria among the Jamaica constabulary

| Parish and constabulary station | 1907 | | | 1908 | | |
|---|---|---|---|---|---|---|
| | No. of cases of malaria at station | No. of S.O's and men at station | Percentage of cases of malaria | No. of cases of malaria at station | No. of S.O's and men at station | Percentage of cases of malaria |
| KINGSTON | | | | | | |
| Sutton Street | 31 | 170 | 18·2 | 36 | 170 | 21·1 |
| Port Royal | — | 6 | — | — | 6 | — |
| Rock Fort | — | 3 | — | — | 3 | — |
| Rae Town | — | 4 | — | — | 4 | — |
| Brown's Town | — | 4 | — | — | 4 | — |
| Franklin Town | — | 4 | — | — | 4 | — |
| South Camp Road | — | 4 | — | — | 4 | — |
| Allman Town | — | 4 | — | — | 4 | — |
| Fletcher's Town | — | 4 | — | — | 4 | — |
| Hannah's Town | — | 4 | — | — | 4 | — |
| Smith's Village | — | 4 | — | — | 5 | — |
| Water Police | 1 | 15 | — | 1 | 15 | — |
| ST. ANDREW | | | | | | |
| Half Way Tree | 19 | 32 | 59·3 | 16 | 41 | 39·0 |
| Cross Roads | 11 | 24 | 45·8 | 9 | 28 | 32·1 |
| Mathilda's Corner | 2 | 11 | 17·2 | — | 13 | — |
| Gordon Town | 3 | 7 | 42·8 | 1 | 7 | 14·2 |
| Guava Ridge | — | 5 | — | 1 | 5 | — |
| Stoney Hill | 2 | 9 | — | — | 9 | — |
| Laurence Tavern | 1 | 10 | 10·0 | 3 | 10 | 30·0 |
| Bull Bay* | 11 | 14 | | — | 3 | — |
| ST. THOMAS | | | | | | |
| Morant Bay | 22 | 14 | 157·1 | 31 | 13 | 238·4 |
| Bath | 2 | 3 | — | 2 | 3 | — |
| Golden Grove | 3 | 3 | — | 3 | 3 | — |
| Port Morant | 3 | 2 | — | 5 | 2 | — |
| Yallas | 3 | 3 | — | 3 | 3 | — |
| Llandewey | 1 | 2 | — | 1 | 2 | — |
| Trinity Ville | 1 | 3 | — | 0 | 3 | — |
| Cedar Valley | — | 3 | — | — | 3 | — |
| Hagley Gap | 1 | 2 | — | 1 | 2 | — |
| PORTLAND | | | | | | |
| Port Antonio | 49 | 25 | 196·0 | 37 | 28 | 132·1 |
| Manchioneal | 5 | 4 | — | — | 4 | — |
| Castle | 4 | 3 | — | 2 | 3 | — |
| Buff Bay | 10 | 4 | 250·0 | 6 | 5 | 120·0 |
| Hope Bay | 4 | 4 | — | 2 | 4 | — |
| St. Margaret's Bay | 3 | 3 | — | 2 | 2 | — |
| ST. MARY | | | | | | |
| Port Maria | 46 | 20 | 230·0 | 56 | 20 | 280·0 |
| Annotto Bay | 61 | 10 | 610·0 | 68 | 10 | 680·0 |
| Castleton | 1 | 3 | — | — | 2 | — |
| Richmond | 5 | 5 | — | 7 | 6 | — |
| Lucky Hill | 2 | 3 | — | 1 | 3 | — |
| Retreat | — | 3 | — | 2 | 3 | — |
| Oracabessa | 3 | 3 | — | 3 | 3 | — |

* Section closed 1 February, 1908

TABLE 10. Showing Spleen Rate and Average Spleen in Various Parishes

| District | Locality | Feet | Number of children Examined | Spleens 1 | 3 | 6 | 9 | Total with enlarged spleens | Spleen rate per cent. | Average spleen |
|---|---|---|---|---|---|---|---|---|---|---|
| St. Thomas ... | Albion ..... | Sea level | 10 | 2 | 1 | 6 | 1 | 8 | 80·0 | 5·0 |
| ,, ... | Yallas..... | ,, | 34 | 25 | 9 | — | — | 9 | 26·4 | 1·5 |
| | | | 44 | 27 | 10 | 6 | 1 | 17 | 38·5 | 2·3 |
| Portland ..... | Port Antonio, East ..... | Sea level | 11 | 2 | 8 | — | 1 | 9 | 81·8 | 3·1 |
| | ,, ,, ,, ..... | ,, | 38 | 12 | 21 | 5 | — | 26 | 68·4 | 2·7 |
| | Bound Brook, West ... | ,, | 15 | 3 | 12 | — | — | 12 | 80·0 | 2·6 |
| | Bound Brook School ... | ,, | 53 | 22 | 30 | 1 | — | 31 | 58·4 | 2·2 |
| | Titchfield School, Lower Division ..... | ,, | 99 | 46 | 45 | 8 | — | 53 | 53·5 | 2·3 |
| | Titchfield School, Intermediate Division ... | ,, | 50 | 22 | 25 | 3 | — | 28 | 56·0 | 2·3 |
| | Titchfield School, Upper Division ..... | ,, | 6 | 4 | 2 | — | — | 2 | 33·3 | 1·6 |
| | Windsor ..... | 200 | 10 | 0 | 8 | 2 | — | 10 | 100·0 | 4·6 |
| | Stanton ..... | ,, | 6 | 1 | 1 | 4 | — | 5 | 83·3 | 4·6 |
| | Louis Hope ..... | ,, | 3 | — | — | 3 | — | 3 | 100·0 | 8·0 |
| | | | 291 | 112 | 152 | 26 | 1 | 179 | 61·5 | 2·5 |
| St. Mary ..... | Annotto Bay ..... | Sea level | 106 | 32 | 60 | 12 | 2 | 74 | 69·8 | 2·85 |
| | Epsom School ..... | 100 | 34 | 23 | 11 | — | — | 11 | 32·3 | 1·6 |
| | Enfield ..... | 200 | 29 | 23 | 6 | — | — | 6 | 26·0 | 1·4 |
| | Fort Stewart ..... | 150 | 27 | 11 | 13 | 3 | — | 16 | 59·2 | 2·5 |
| | Cape Clear ..... | 250 | 15 | 6 | 9 | — | — | 9 | 60·0 | 2·2 |
| | Chovey ..... | 100 | 24 | 16 | 8 | — | — | 8 | 33·3 | 2·0 |
| | Orange Hill ..... | 100 | 64 | 41 | 18 | 5 | — | 23 | 35·9 | 1·95 |
| | Bremmerhall ..... | slightly above | 25 | 17 | 8 | — | — | 8 | 32·0 | 1·6 |
| | Fontabelle ..... | ,, | 12 | 8 | 4 | — | — | 4 | 33·3 | 1·6 |
| | Trinity ..... | ,, | 14 | 6 | 7 | 1 | — | 8 | 57·1 | 2·3 |
| | Port Maria ..... | Sea level | 48 | 33 | 14 | 1 | — | 15 | 31·2 | 1·5 |
| | | | 398 | 216 | 158 | 22 | 2 | 182 | 45·7 | 2·1 |
| St. Ann ..... | Brown's Town..... | 1000 | 69 | 69 | — | — | — | 0 | Nil | 1·0 |
| Trelawny ..... | Falmouth ..... | Sea level | 102 | 100 | 2 | — | — | 2 | 1·96 | 1·09 |
| | Duan Vale ..... | 300 to 400 | 87 | 87 | — | — | — | 0 | 0 | 1·00 |
| | | | 189 | 187 | 2 | — | — | 2 | 1·06 | 1·03 |

TABLE 10. Showing Spleen Rate and Average Spleen in Various Parishes

| District | Locality | Feet | Number of children Examined | Spleens 1 | 3 | 6 | 9 | Total with enlarged spleens | Spleen rate per cent. | Average spleen |
|---|---|---|---|---|---|---|---|---|---|---|
| St. Thomas ... | Albion ..... | Sea level | 10 | 2 | 1 | 6 | 1 | 8 | 80·0 | 5·0 |
| ,, ... | Yallas..... | ,, | 34 | 25 | 9 | — | — | 9 | 26·4 | 1·5 |
| | | | 44 | 27 | 10 | 6 | 1 | 17 | 38·5 | 2·3 |
| Portland ..... | Port Antonio, East ..... | Sea level | 11 | 2 | 8 | — | 1 | 9 | 81·8 | 3·1 |
| | ,, ,, ,, ..... | ,, | 38 | 12 | 21 | 5 | — | 26 | 68·4 | 2·7 |
| | Bound Brook, West ... | ,, | 15 | 3 | 12 | — | — | 12 | 80·0 | 2·6 |
| | Bound Brook School .... | ,, | 53 | 22 | 30 | 1 | — | 31 | 58·4 | 2·2 |
| | Titchfield School, Lower Division ..... | ,, | 99 | 46 | 45 | 8 | — | 53 | 53·5 | 2·3 |
| | Titchfield School, Intermediate Division ... | ,, | 50 | 22 | 25 | 3 | — | 28 | 56·0 | 2·3 |
| | Titchfield School, Upper Division ..... | ,, | 6 | 4 | 2 | — | — | 2 | 33·3 | 1·6 |
| | Windsor ..... | 200 | 10 | 0 | 8 | 2 | — | 10 | 100·0 | 4·6 |
| | Stanton ..... | ,, | 6 | 1 | 1 | 4 | — | 5 | 83·3 | 4·6 |
| | Louis Hope ..... | ,, | 3 | — | — | 3 | — | 3 | 100·0 | 8·0 |
| | | | 291 | 112 | 152 | 26 | 1 | 179 | 61·5 | 2·5 |
| St. Mary ..... | Annotto Bay ..... | Sea level | 106 | 32 | 60 | 12 | 2 | 74 | 69·8 | 2·85 |
| | Epsom School ..... | 100 | 34 | 23 | 11 | — | — | 11 | 32·3 | 1·6 |
| | Enfield ..... | 200 | 29 | 23 | 6 | — | — | 6 | 26·0 | 1·4 |
| | Fort Stewart ..... | 150 | 27 | 11 | 13 | 3 | — | 16 | 59·2 | 2·5 |
| | Cape Clear ..... | 250 | 15 | 6 | 9 | — | — | 9 | 60·0 | 2·2 |
| | Chovey ..... | 100 | 24 | 16 | 8 | — | — | 8 | 33·3 | 2·0 |
| | Orange Hill ..... | 100 | 64 | 41 | 18 | 5 | — | 23 | 35·9 | 1·95 |
| | Bremmerhall ..... | slightly above | 25 | 17 | 8 | — | — | 8 | 32·0 | 1·6 |
| | Fontabelle ..... | ,, | 12 | 8 | 4 | — | — | 4 | 33·3 | 1·6 |
| | Trinity ..... | ,, | 14 | 6 | 7 | 1 | — | 8 | 57·1 | 2·3 |
| | Port Maria ..... | Sea level | 48 | 33 | 14 | 1 | — | 15 | 31·2 | 1·5 |
| | | | 398 | 216 | 158 | 22 | 2 | 182 | 45·7 | 2·1 |
| St. Ann ..... | Brown's Town..... | 1000 | 69 | 69 | — | — | — | 0 | Nil | 1·0 |
| Trelawny ..... | Falmouth ..... | Sea level | 102 | 100 | 2 | — | — | 2 | 1·96 | 1·09 |
| | Duan Vale ..... | 300 to 400 | 87 | 87 | — | — | — | 0 | 0 | 1·00 |
| | | | 189 | 187 | 2 | — | — | 2 | 1·06 | 1·03 |